Volume 24, Number 1, January 15, 1970

NUCLEAR SCIENCE ABSTRACTS

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Personal Authors

Each author's name is indexed in the form appearing on the document abstracted:

```
ISHIHARA, T.
  Accumulation of fallout 137Cs in newborn infants,
    23:50538
ISHIHARA, Toyokuki
  Shielding effect of paraffin, water, soil, concrete, Fe,
    and Pb for high-energy neutrons,  23:51748
```

Subjects

The subject index consisting of specific materials, objects, and processes is arranged alphabetically. Modifying phrases specific to these subjects in turn are arranged alphabetically under the subjects.

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MELPHALAN
  effects on proliferation of cultured antigen-stimulated
    spleen cells from mice, dose-response curve for,
    23:50820
MEMBRANE FILTERS
  design for removal of cell-free Streptococcus faecalus
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MEMBRANES
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    extraction using sodium amalgam,  23:49772 (UCRL-18667,
    pp 277-312)
  stability of divalent state of,  23:49772 (UCRL-18667, pp
    277-312)
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Corporate Authors

Technical report literature is indexed from the name of the organization or institution responsible for the issuance of the report.

51093 (LA-4164) FABRICATION OF BORON CARBIDE RINGS AND DISKS. Sheinberg, H.; Herrera, T.; Kostacopoulos, J. (Los Alamos Scientific Lab., N. Mex.). Apr. 25, 1969. Contract W-7405-eng-36. 11p. Dep. CFSTI.

is indexed as:

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  781/I        23-52462  Dep
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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 331, 409, 417, 438, 455, 475, and 486.

Chemical and Spectral Procedures

Refer also to abstracts 179, 274, and 970.

1 (ANL-Trans-783) POSSIBILITY OF XENON COMPOUNDS SYNTHESIS UNDER NATURAL CONDITIONS. Gucev, Yu. K.; Ucopov, V. K.; Kirin, I. S.; Dikhonova, A. E. Translated for Argonne National Lab., Ill., from Geokhimiya, [No.] 7, 835-9(1969). 9p. Dep. CFSTI.

The possibility of xenon compound formation under natural conditions was considered. Mass spectrometric methods of searching for xenon compounds in minerals containing U, Th, Te, I and soluble in nitric, sulfuric and hydrofluoric acids are proposed. The method is based on the use of differences in physicochemical properties of xenon and its compounds. The possibility of using the proposed methods was verified on preparations of iodine pentoxide irradiated by neutrons. It is shown that 1 to 3 per cent of the total amount of ^{128}Xe that is formed during irradiation of iodine pentoxide by neutrons proves to be in a chemically bound state. (auth)

2 (BAW-4088-1) LMFBR/FFTF FUEL QUALITY CONTROL AND ASSURANCE ANALYTICAL CHEMISTRY PROGRAM. Phase II, Final Technical Report. Schmitt, D. H. (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.). Sept. 1969. Contract AT(30-1)-4088. 208p. Dep. CFSTI.

The Babcock & Wilcox Analytical Laboratory participated in Phase II of the LMFBR/FFTF Fuel Quality Control and Assurance Analytical Chemistry Program in order to determine B&W's capabilities for analyzing FFTF fuels using the same or comparable methods and conditions as those that were recommended. Sintered $(U,Pu)O_2$ pellets and mixed oxide powder obtained from the Los Alamos Scientific Laboratory were analyzed as requested. Results were obtained for the following measurements: uranium and plutonium assay, spectrographic impurities, O/M ratio, halogens, carbon, nitrogen, density, water content, homogeneity, and gas content. (auth)

3 (NIM-433) THE SPECTROPHOTOMETRIC DETERMINATION OF MICROGRAM QUANTITIES OF VANADIUM IN U_3O_8, UO_3, AND UF_4. Silverthorne, D. F.; Russell, B. G.; Steele, T. W. (National Inst. for Metallurgy, Johannesburg (South Africa)). Dec. 6, 1968. 7p. Dep. CFSTI (U. S. Sales Only).

The uranium compound is dissolved and the vanadium separated by ion exchange. A PAR solution was used to form a color for spectrophotometric determination of the V. The procedure is applicable to UF_4, UO_3, and U_3O_8, in which the vanadium content is between 0.5 and 125 ppM. (M.C.G.)

4 DETERMINATION OF RHENIUM AND MOLYBDENUM AND THEIR SEPARATION FROM EACH OTHER AND OTHER IONS BY INTERNAL ELECTROLYSIS. Majumdar, A. K.; Bhowal, Gouri (Jadavpur Univ., Calcutta). Anal. Chim. Acta, 48: 192-5(Nov. 1969).

Methods are described for the separation and determination of rhenium and molybdenum in the presence of large numbers of foreign ions, such as Fe, Al, Cr, Ti, Th, Zr, U(VI), Be, Zn, Mn, W(VI), V(V), La, Ta(V), alkali and alkaline earths, Pb, and Ca using EDTA as complexing agent. (D.H.M.)

5 THE DETERMINATION OF THALLIUM IN SILICATE ROCKS, MARINE SEDIMENTS, AND SEA WATER. Matthews, A. D.; Riley, J. P. (Univ. of Liverpool). Anal. Chim. Acta, 48: 25-34(Nov. 1969).

An anion exchange scheme was developed for the preconcentration and almost specific separation of microgram and submicrogram amounts of thallium. It is used in conjunction with a fluorimetric method based on rhodamine B for the determination of 0.1 to 6 ppM of thallium in silicate rocks and sediments. The method showed a coefficient of variation of 1.2% at the 6 ppM level. A procedure is also described for the determination of thallium in natural waters in which the element is concentrated by anion exchange and determined by neutron activation. A sample of water from the Irish Sea was found to contain 18.7 ± 0.9 ng Tl/l. (auth)

6 EVALUATION OF ELECTRON SPIN RESONANCE FOR QUANTITATIVE DETERMINATIONS OF GADOLINIUM, CHROMIUM, IRON, COPPER, AND MANGANESE. Moyer, E. S.; McCarthy, W. J. (West Virginia Univ., Morgantown). Anal. Chim. Acta, 48: 79-85(Nov. 1969).

The use of ESR as a routine quantitative analytical tool for nondestructive analysis of several metal ions in solution is examined. This application required the evaluation of numerous experimental parameters which affect the signal production. Limits of detection and analytical curves are presented for gadolinium, copper, iron, manganese, and chromium in ethanolic solution. Analytical selectivity and convenience of analysis are examined. (auth)

7 N-BENZOYL-N-PHENYLHYDROXYLAMINE AS A COLORIMETRIC REAGENT FOR CERIUM. Murugaiyan, P.; Das, M. Sankar (Bhabha Atomic Research Centre, Trombay, India). Anal. Chim. Acta, 48: 155-60(Nov. 1969).

N-Benzoyl-N-phenylhydroxylamine is recommended as a spectrophotometric reagent for cerium. It extracts cerium in the pH range 8 to 10. Beer's law is obeyed in the concentration range of 4 to 40 ppM of CeO_2. Cerium(III) is oxidized automatically to cerium(IV) during the color development stage. The method was applied to samples such as lanthanum oxide, cerium glass, G-1 and carbonatites. (auth)

8 INDIRECT AMPLIFICATION DETERMINATION OF THORIUM BY ATOMIC ABSORPTION SPECTROSCOPY. Kirkbright, G. F.; Rao, A. P.; West, T. S. (Imperial Coll. of Science and Tech., London). Spectrosc. Lett., 2: 69-74(Mar. 1969).

A Th phosphomolybdic acid complex (MThPA) is formed in 0.15F HCl in the presence of excess phosphomolybdic acid, and this excess is then extracted into isobutyl acetate. The MThPA is then extracted into n-butanol; the organic phase is washed with 0.15F HCl and aspirated directly into a fuel-rich $N_2O-C_2H_2$ flame. The 11 Mo atoms associated with each Th atom in the complex are then determined by measuring the atomic absorption of the Mo at 313.2 nm). The optimum conditions found for the most sensitive determination of Th were: phosphate concentration, 3.2×10^{-4}F; molybdate concentration, 2.3×10^{-2}F. The calibration graph is linear over the range 25 to 150 μg Th. A 100-fold weight excess of Ca, Co(II), Cu(II), Ba, Mn(II), Mg, Ni, Pb, Zn, acetate, SO_4, SCN^-, and oxalate did not produce any interference; Bi, La, and UO_2(II) at <50-fold weight excess gave no interference. Although Zr, Fe(III), Si, As, Ti, and Nb interfere, procedures for removal or masking them are suggested. (BBB)

9 AMPEROMETRIC TITRATION OF SMALL AMOUNTS OF ALUMINUM. Breckenridge, J. H.; Harris, W. E. (Univ. of Alberta, Edmonton). Anal. Lett., 2: 473-8(Sept. 1969).

An amperometric titration of aluminum using iron(III) as the amperometric indicator and thorium as the titrant was developed. The method is based on the fact that aluminum interferes in fluoride titrations. At a fixed fluoride concentration there is an inverse linear relationship between the amount of thorium used and the aluminum concentration. (auth)

10 SENSITIVITY OF SPECTROGRAPHIC ANALYSIS FOR CERTAIN RARE AND RARE-EARTH METALS IN A HIGH-VOLTAGE A.C. ARC. Trapitsyn, N. F. Tr. Frunz. Politekh. Inst., No. 23, 82-6(1967). (In Russian).

The elements are introduced into the arc as salts or oxides, mixed with carbon powder (and sometimes with KCl also) or with copper powder. Portions (20 mg) of mixtures with carbon are packed into the groove of a carbon electrode, and mixtures with copper powder are made into briquettes of weight 50 or 20 mg, which are placed on the lower carbon or copper electrode. Under various excitation conditions, the best sensitivity (%) attainable was: 10^{-4} for most elements; 10^{-6} for Yb; 5×10^{-4} for Ho; 10^{-3} for Pr, Nd, Sm or Dy; 5×10^{-3} for Tb; 10^{-2} for Ce; and 10^{-1} for Ga. The determination of Yb, Er, Gd, Tb, Dy, and Ho is carried out from lines in the CN-band region, attenuated by including 5 to 10% of KCl in the sample in the lower electrode or 30 to 40% of KCl in the upper. For some elements, the sensitivity can be improved by including various additives in the sample, e.g., the addition of 5% of LiOH or KCl improved the sensitivity for Sm 200-fold. The sensitivity is superior to that attained with a dc arc, and as good as that attained by evaporation of solutions from the end of the electrode. (Referativnyi Zh.)

11 DETERMINATION OF BORON, STRONTIUM, AND SILICON IN SEA WATER BY EMISSION SPECTROSCOPY. Lotrian, J.; Johannin-Gilles, Andree (Faculte des Sciences, Brest, France). Spectrochim. Acta, Part B, 24: 479-95(Sept. 1969). (In French).

Boron, strontium, and silicon in seawater were determined by emission spectroscopy using three different sources, e.g., tube electrode-spray-method, rotrode and porous cup, without any chemical pretreatment. Optical working conditions (electric parameters, dimensions, flow rates of liquid and eventually gas) of these sources, which were provided with a magnetic stabilization system, were studied and compared. This work proves the superiority of the tube-spray-method as far as reproductibility of results and power of detection is concerned. Concentration values of 1.90 mg/l for Si and 4 to 5 mg/l for B were measured. (auth)

12 DETERMINATION OF METALS BY PHOTOCHEMICAL PRECIPITATION. Agarwal, R. P.; Heyn, Arno H. A.; Hoffman, Morton Z. (Boston Univ.). Anal. Lett., 2: 485-9(Sept. 1969).

The technique of precipitation from homogeneous solution by photochemical action was successfully applied to the determination of La, Ba, and In. Precipitation is accomplished through the photoreduction of IO_4^- to produce the insoluble iodates. In the case of Zr and Ti, the more soluble periodate is coprecipitated with the iodate and the method is not successful. Cu and Ni cannot be estimated by this method. (auth)

13 CHIMIE ANALYTIQUE. BASES THEORIQUES-RADIOCHIMIE-QUALITATIVE. (Analytical Chemistry. Theoretical Foundation, Radiochemistry, Qualitative). Monnier, Denys; Haerdi, Werner; Rusconi, Yvonne. Geneve, Georg and Cie S.A., 1968. 323p.

Information is given on fundamental theoretical principles of modern analytical chemistry and practical qualitative analysis. Chapters are included on: structure of the atom, periodic table, and valences; particles in solution and chemical equilibria; acids and bases; curves of neutralization and buffer effect; complexes; solubility and solubility product; oxidation-reduction; electrochemical reactions and polarization curves; determination of the concentration of particles in solution, apparent constants, and interaction between the various types of equilibria; graphic representations and exponential laws in analytical chemistry; nonaqueous solvents; radiochemical analysis; separation methods; precautions to take—how to avoid accidents; generalities and general course of analysis; principal techniques of the fundamental operations of analysis by dry methods and by wet methods; disintegrations; reactions for identification of cations and anions; analysis of cations and anions by wet methods; and analysis by specific reactions with separations. (P.C.H.)

14 DIFFUSION-THERMAL IONIZATION SOURCE FOR MASS SPECTROMETRIC ASSAY OF TRACE METALS. Myers, W. G.; White, F. A. (Rensselaer Polytechnic Inst., Troy, N. Y.). Anal. Chem., 41: 1861-4(Nov. 1969).

An improved thermal ionization source for the mass spectrometric assay of trace metals was developed, based on the concept of implanting sample and tracer atoms within the crystalline lattice of a refractory material. The diffusion controlled release of the sample, regardless of its original chemical form, from within the source material, provides ion emission currents that allow precise isotopic ratio measurements to be made. On the basis of the experimental results obtained, it would appear that the advantages of high-temperature operation of single-filament thermal ionization sources were achieved while either reducing or eliminating their inherent disadvantages. The sample encapsulation techniques investigated in this study, while not fulfilling theoretical boundary conditions, did function to retain most of the sample long enough so that crystalline lattice "impregnation" conditions could be achieved before prohibitive loss, via evaporation, had occurred. (M.C.G.)

15 COMPLEXOMETRIC TITRATIONS. SECOND EDITION. Schwarzenbach, G.; Flaschka, H. London, Methuen, 1969. 490p. 90s.

Translated from the German text by H. M. N. H. Irving.

Titration procedures and working instructions are included for the following elements of nuclear interest: Li, Cs, Be, Ba, Sr, B, yttrium and rare earths, Pu, Zr, Hf, Th, V, Nb, Ta, Mo, W, U, Ga, and C. An extensive bibliography is presented. (UK)

16 DIRECT METHOD (CATHODE REGION) FOR THE SPECTROCHEMICAL DETERMINATION OF RARE EARTHS IN URANIUM, THORIUM, AND ZIRCONIUM MATRICES. Avni, R.; Boukobza, A. (Israel Atomic Energy Commission, Beer Sheva). Spectrochim. Acta, Part B, 24: 515-31(Sept. 1969).

In a dc arc, burning in air at atmospheric pressure, the cathode region was exposed instead of the whole plasma. Traces of rare earths, yttrium, and scandium were determined directly in the refractory matrices of uranium, thorium, and zirconium oxides. The evaporation rate of the elements was increased by adding to U_3O_8 or ThO_2 or ZrO_2, 4% of their respective fluorides, or the equivalent amount of fluoride in the Teflon spray form. The behavior of the cathode region under fluoride–oxide–graphite conditions was studied, measuring the "axial" gradients, such as temperature, voltage, electron density, and total particle concentration of the involved elements. Matrix factors were calculated. The detection limits of rare earth impurities are in the concentration range of few micrograms. A mean precision of ±18% was obtained for concentrations up to 400 μg/g. (auth) (UK)

17 RAPID DETECTION AND DETERMINATION OF TELLURIUM IN THE PRESENCE OF SELENIUM. Makhmetov, M. Zh.; Polukarov, A. N. Tr. Khim.-Met. Inst., Akad. Nauk Kaz. SSR, 3: 52-4(1967). (In Russian).

The method is based on reduction of Te(IV) and Te(VI) to elementary Te by means of $Na_2S_2O_5$ at pH 6; Se(IV) is also reduced, but remains in solution as selenosulfate. The sensitivity of the reaction is ≈0.4 mg of Te in 100 ml of solution. The method can be used to separate 1 to 200 mg of Te from 0.2 to 1 g of Se; Cu and Pb do not interfere. The test solution is diluted (e.g., that obtained by aqueous extraction of copper-electrolyte slime sintered with Na_2CO_3) to 50 or 100 ml, heated to 80 to 90°, and $Na_2S_2O_5$ is added slowly (excess does not interfere) until a weakly acid reaction is obtained (pH 6). The solution is then boiled for 5 to 10 min, the precipitate is collected, washed with hot H_2O, and Te is determined iodometrically. (Referativnyi Zh.)

18 SPECTROPHOTOMETRIC AND VISUAL TITRATIONS OF MILLIGRAM AMOUNTS OF STRONTIUM WITH EDTA. Salomon, Jean; Vance, John E.; Baase, Walter A. (New York Univ., N. Y.). Anal. Chem., 41: 1864-6(Nov. 1969).

Experiments showed that the presence of 10 mmole of NaCl decreases both the precision and accuracy of the determinations but does not impair their utility; the visual titration is fully as satisfactory as the more time-consuming spectrophotometric method. (M.C.G.)

19 RADIOCHEMICAL STANDARDIZATION OF OXIDANT DETECTORS FOR IODINE. Ludwick, J. D. (Battelle Memorial Inst., Richland, Wash.). Anal. Chem., 41: 1907-8(Nov. 1969).

A general method is described for calibrating instrumentation in a flow system. The specific method uses radioiodine as a tracer and is applicable to any material in a flow system that can be tagged in a similar manner. A known amount of iodine gas containing a specific quantity of ^{131}I was generated chemically into an auxiliary vessel and injected at a controlled rate into a known-volume air stream. A comparison of instrument response with γ analysis for determination of ^{131}I allows the precise calibration of the equipment. (M.C.G.)

Radiometric Procedures

Refer also to abstracts 424, 428, and 564.

20 DETERMINATION OF THE URANIUM CONCENTRATION IN PLANTS ACCORDING TO TRACES OF URANIUM FISSION FRAGMENTS. Abdullaev, Kh.; Zakhvataev, B. B.; Pereiygin, V. P. (Joint Inst. of Nuclear Research, Dubna, USSR). Radiobiologiya, 8: 765-6(1968). (In Russian).

The use of lavsan to measure the uranium concentration in plants by recording fission fragments of ^{235}U in thermal neutron fluxes is described. The use of external detectors of organic polymers permits a determination of very low uranium concentrations in plants. (JPRS)

Activation Procedures

Refer also to abstract 1684.

21 AUTOMATED SOLVENT-EXTRACTION TECHNIQUE FOR RADIOCHEMICAL GROUP SEPARATIONS: APPLICATION TO THE ANALYSIS OF GLASS FRAGMENTS BY THERMAL-NEUTRON ACTIVATION. Goode, G. C.; Baker, C. W.; Brooke, N. M. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Analyst, 94: 728-36(Sept. 1969).

An apparatus suitable for automated radiochemical group separation by a solvent extraction technique is described, together with a scheme applicable to the determination of twenty-five elements in milligram samples of glass by thermal-neutron activation analysis. The separation scheme involves sequential extraction of five groups of trace elements from a perchloric acid solution of the glass by selective complexing with thenoyltrifluoroacetone, diethylammonium, diethyldithiocarbamate and tributyl phosphate, under controlled pH conditions. Individual γ-ray spectra are resolved by a least squares fitting programme. A precision of 7%, or better, can be achieved for twelve elements, and results for a variety of window-glass samples of different origin are presented to illustrate the possible forensic applications. (auth) (UK)

22 DETERMINATION OF IMPURITIES IN TITANIUM AND TITANIUM DIOXIDE BY NEUTRON ACTIVATION ANALYSIS. PART IV. DETERMINATION OF TRACE IMPURITIES IN TITANIUM DIOXIDE SINGLE CRYSTALS. Neirinckx, R.; Adams, F.; Hoste, J. (Univ., Ghent). Anal. Chim. Acta, 48: 1-11(Nov. 1969).

The method is based on reactor irradiation and Ge(Li) spectrometry. An anion exchange separation followed by TBP solvent extractions, allows a rapid and accurate determination of up to 21 metallic impurities in titanium dioxide crystals. Of the elements investigated, only hafnium and protactinium, radioactive daughter of thorium, stayed with the matrix activity and hence could not be determined. Triplicate determinations were performed of three different samples. The sensitivity ranged from 10^{-12} g for iridium, to 5×10^{-8} g for barium, for reactor irradiation at a thermal neutron flux of 5×10^{12} n cm^{-2} sec^{-1} during one week. (auth)

23 INSTRUMENTAL ACTIVATION ANALYSIS OF SILICATE ROCKS WITH EPITHERMAL NEUTRONS. Brunfelt, A. O. (Univ. of Oslo); Steinnes, E. Anal. Chim. Acta, 48: 13-24(Nov. 1969).

The determination of some trace elements in standard rocks by epithermal neutron activation, followed by γ-ray spectrometry with a Ge(Li) detector, is described. The advantage of using this technique compared to corresponding analysis with thermal neutrons is clearly demonstrated in the case of Rb, Cs, Sr, Sb, Ta, and U. Determinations of Ba, Sm, Tb, Hf, and Th also appear to be favorable. (auth)

24 THE APPLICATION OF THE ACTIVATION ANALYSIS TO THE INVESTIGATION OF SORPTION AND SUBLIMINATION PROPERTIES OF HIGH-TEMPERATURE MATERIALS. Maslov, I. A.; Lusknitskii, V. A.; Karnaukhova, N. M.; Karayanova, G. I. (Ioffe Inst. of Physics and Tech., Leningrad). pp 551-62 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Problems dealing with sorption and sublimation properties of high-temperature substances studied by neutron activation analysis were: absorption of Cs vapor by electroinsulating ceramics and measurement of evaporation rate of Mo and ZrC in vacuum. Not only the total Cs content of the insulating rings, but the degree of adsorbed Cs removable by washing and the degree of Cs penetration of the $Al_2O_3-Y_2O_3$ ceramic was determined. A special apparatus is described for the evaporation experiments, and the rate of evaporation was measured as a function of temperature. Under the same conditions, the evaporation rate of ZrC is about 2 orders of magnitude less than Mo. The impurities in ZrC were determined and found to be Sb, Zn, Ta, and Hf, which influenced the evaporation rate. (B.L.M.)

25 DIVERSIFIED INSTRUMENTAL NUCLEAR ANALYSIS METHODS USING A REACTOR. Nass, H. W. (Union Carbide Corp., Tuxedo, N. Y.). pp 563-73 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Some instrumental nuclear methods using a reactor are: (1) Use of Cd-covered samples to suppress the production of interfering radionuclides, (2) Determination of deuterium by the photoneutron method, (3) Determination of U by delayed neutron method, and (4) Use of solid state detectors to resolve short-lived radionuclides of interest in the presence of other nuclides of similar γ ray emissions. These methods are discussed briefly. Bromine determination in certain materials, such as seawater or blood, is a good example of Cd-covered irradiations. Quantitative determination of deuterium down to 2 μg is possible by measurement of the neutron liberated from the nucleus by γ irradiation, and the method is applicable to body water samples. The sensitivity of the determination of ^{235}U by delayed neutron measurement is 0.05 μg and is virtually independent of the matrix. The Ge(Li) detectors yield a 10 to 50 fold increase in resolution over Na(Tl) detectors; however, a 100 fold decrease in sensitivity normally accompanies the increased resolution. Selenium can be determined in the presence of Sc and O using a Ge(Li) detector. Other applications of these techniques are mentioned. (B.L.M.)

26 MAJOR CONSTITUENTS DETERMINATION IN SUBSTANCES BY ACTIVATION ANALYSIS. Cappadona, Carmelo (Univ., Palermo, Italy). pp 574-6 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

A method for the determination of a macrocomponent of a substance by activation, chemical separation, and isotopic dilution is described. The method is illustrated with the determination of Au in an Au-Cu alloy. The method was also applied to the determination of Sn, P, and Cu in alloys, and the error of the determination was <1%. (B.L.M.)

27 RADIOCHEMICAL SEPARATIONS FOR ACTIVATION ANALYSIS. Girardi, F. (EURATOM, Ispra, Italy). pp 577-616 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

A review of the radiochemical separation developments and a survey of future problems and future developments with 84 references cited are presented. Pretreatment of samples in both organic and inorganic matrices is discussed. The various standard separation techniques, i.e., precipitation, chromatography, distillation, etc., are discussed with application to radiochemistry. The various elements are divided into groups and group separations with schematics are presented. Automatic separations, both by fixed program machines and by programmable machines, are discussed. Finally, new developmental trends are discussed in some detail. (B.L.M.)

28 GAS CHROMATOGRAPHIC SEPARATIONS IN NEUTRON ACTIVATION ANALYSIS. Cram, Stuart P.; Varcoe, Fredrick T. (Univ. of Florida, Gainesville). pp 620-3 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

The coupling of gas chromatographic separation with neutron activation is discussed. The experiments were limited to post-irradiation separations, and the optimum experimental conditions were determined. The chromatographic column effluents were analyzed by multichannel scaling and/or pulse height scintillation spectrometry. (B.L.M.)

29 RAPID GROUP SEPARATION METHOD FOR NEUTRON ACTIVATION ANALYSIS OF GEOLOGICAL MATERIALS. Peterson, S. F.; Travesi, A.; Morrison, G. H. (Cornell Univ.,

Ithaca, N. Y.). pp 624-33 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

A group separation method was developed for use with rock samples in order to take full advantage of the resolution of the γ spectra by Ge(Li) detectors after neutron irradiation. The sample components are separated into 5 groups, and the procedure takes ~3 to 4 hr after irradiation. The separation scheme is summarized graphically. The results for determination of 16 elements in U.S. Geological Survey Standard rocks are tabulated. No attempt was made to determine the sensitivity or detection limits. (B.L.M.)

30 GROUP RADIOCHEMICAL SEPARATIONS: A PRACTICAL APPROACH TO ACTIVATION ANALYSIS. Thompson, Barbara A. (National Bureau of Standards, Washington, D. C.). pp 634-8 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Illustrations are given of the purpose and place of group separations in activation analysis to make it accurate, precise, sensitive, rapid, and applicable to a wide range of samples. Determination of the impurities at the ppB level in high-purity Zn and the determination of minor constitutents in steel and cast iron are used as illustrations. The group separations used for these samples are shown schematically. For analysis of steel, the only separations necessary if a Ge(Li) detector was used was the separation of Mo from the Fe matrix and As from any Sb that might be present. Copper, Cr, Co, Ga, and W need not be separated. Silver, Sb, Au, Ga, Sc, As, Mo, W, and Ir were determined in 3 fractions from the Zn sample; however, only the upper limits could be determined for most elements. Antimony, Ag, and Au, which were determined to be present, were distributed inhomogeneously. (B.L.M.)

31 RADIOCHEMICAL SEPARATIONS BY RETENTION ON INORGANIC PRECIPITATES. Girardi, F.; Pietra, R.; Sabbioni, E. (CCR-EURATOM, Ispra, Italy). pp 639-41 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

A survey was made of the retention of ions on a variety of materials from different media. Data were collected for behavior of different elements for each column-medium combination and behavior of different column-medium combinations for each element. Six of the 17 materials studied did not present any special interest. Hydrated manganese dioxide, hydrated antimony pentoxide, and SnO_2 gave a variety of useful applications. The affinity of aluminum oxide for PO_4^{3-}, coupled to a sufficiently high selectivity, makes it interesting for reduction of bremsstrahlung for γ spectra of biological specimens. The 3 phosphates of Zr, Ti, and Sn were noted to still have good exchange properties at high ionic strength. Copper sulfide was found to be good for separating Cu by isotopic exchange while CuCl has a marked affinity for bromides and iodides. A variety of separations schemes are possible and selection of the proper one for a given problem lends itself to computer selection. (B.L.M.)

32 CHROMIUM SEPARATION BY INORGANIC EXCHANGERS IN ACTIVATION ANALYSIS OF BIOLOGICAL MATERIALS. Meloni, Sandro; Brandone, Alberto; Maxia, Vera (Univ., Pavia, Italy). pp 642-5 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Samples of human blood serum and red cells were analyzed for Cr by neutron irradiation. A radiochemical separation was necessary before the γ activity could be measured. The Na and K were absorbed on hydrated antimony pentoxide; and the P, which is troublesome because of the bremsstrahlung from ^{32}P, in the eluate is adsorbed on SnO_2 from which Cr is eluted with HNO_3. Finally the Cr is adsorbed onto MnO_2, filtered, and dried for counting. Typical results are shown, and the precision of the results is ~4%. (B.L.M.)

33 RADIOCHEMICAL SEPARATIONS FOR ACTIVATION ANALYSIS USING BIS(2-ETHYL-HEXYL) ORTHOPHOSPHORIC ACID. Qureshi, I. H.; McClendon, L. T.; LaFleur, P. D. (National Bureau of Standards, Washington, D. C.). pp 666-71 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

A comprehensive study of the extraction of metal ions into HDEHP from 1M to 11M HNO_3, HCl, and $HClO_4$ is reported. The general extraction mechanisms are discussed with actual results shown graphically for each of the three acids. The results of this study indicate that HDEHP is a useful extractant and holds promise for group radiochemical separations. (B.L.M.)

34 NEUTRON, PHOTON, AND CHARGED PARTICLE REACTIONS FOR ACTIVATION ANALYSIS. De Soete, D.; Gijbels, R.; Hoste, J. (Ghent Univ.). pp 699-750 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

Neutron-induced reactions are discussed at length with special attention being given to energy considerations and thresholds, cross sections, fast neutron activation, and determination of neutron fluxes for neutrons both from reactors and isotope sources. Gamma-induced reactions of two general types, (γ,γ) and $(\gamma,$ particle), are discussed. Reaction thresholds, reaction cross sections, reaction rates, and photon production are considered for γ-induced reactions. Several aspects of charged-particle reactions are presented. All types of induced reactions are related to actual analyses. 89 references. (B.L.M.)

35 STUDY OF A BEAM OF CHARGED PARTICLES; THEIR SLOWING DOWN, AND THEIR ENERGY DISTRIBUTION IN A THICK, COMPLEX TARGET FOR ACTIVATION ANALYSIS. Tran, Minh Duc; Tousset, Jean (Faculte des Sciences, Lyon). pp 754-67 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

Studies are described for the determination of the parameters of a particular beam and of the way in which these parameters change as the beam traverses the target material. Methods for measurement of energy resolution of the beam and for determination of the loss of energy and of resolution in a complex chemical compound are described. A mathematical treatment of the stopping power and energy distribution data provides a correction factor, K, which permits calculation of true excitation functions. (B.L.M.)

36 RANGE TRANSFORMATION OF ACTIVATION CURVES AND THEIR APPLICATION TO QUANTITATIVE CHARGED PARTICLE ACTIVATION ANALYSIS. Rook, H. L.; Schweikert, E. A.; Wainerdi, R. E. (Texas A and M Univ., College Station). pp 768-73 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

A method is described for determining a well-defined activation curve for a charged particle in a given material. The method includes a provision using a differential range-energy relationship for transferring the curve into any other matrix. The construction of a synthetic activation curve from an experimental one is illustrated using the activation curve for $^{18}O(\alpha,pn)^{18}F$ with α particles at 40 MeV. (B.L.M.)

37 CONTRIBUTION TO ACTIVATION ANALYSIS BY CHARGED PARTICLES, DETERMINATION OF CARBON AND OXYGEN IN PURE METALS, POSSIBILITIES OF SULPHUR DETERMINATION. Debrun, Jean-Luc; Barrandon, Jean-Noel; Albert, Ph. (CNRS, Vitry, France). pp 774-84 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

Results of the determination of C and O in high-purity Fe, Ni, and Cr samples by irradiation with ^3He and ^4He particles are presented. The interference of F with the O determination was studied up to 30 MeV with ^3He and up to 55 MeV with ^4He. The interference of B and O with the C determination was studied up to the same energy levels with the same particles. Sulfur can be determined by irradiation with charged particles to lead to ^{34m}Cl,

but with ^3He and ^4He the interferences cannot be limited and are rather important. With deuterons, protons, and tritons the energy can be limited and there are no interferences. (B.L.M.)

38 INFLUENCE OF CHANNELING IN CUSTOMARY ^3He ACTIVATION ANALYSIS. Ricci, Enzo (Oak Ridge National Lab., Tenn.). pp 785-90 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

Channeling effects with ^3He were studied for slices perpendicular to the 111 plane of a single Ge crystal to determine the effects of C and O impurities. The results indicate that within experimental error the induced radioactivity is independent of the irradiation angle. Even though a much higher degree of optical alignment was used than is customary in charged-particle activation analysis, the precision is not yet high enough to detect channeling effects. Thus, such effects probably do not generally influence the customary results. (B.L.M.)

39 SURFACE ANALYSIS OF GOLD AND PLATINUM DISKS BY ACTIVATION METHODS AND BY PROMPT RADIATION FROM NUCLEAR REACTIONS. Butler, James W.; Wolicki, Eligius A. (Naval Research Lab., Washington, D. C.). pp 791-3 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

A typical analytical procedure for the determination of traces of C and O on the surface of Au and Pt discs by activation with ^3He and measurement of prompt radiation is described. The uncertainty of the results, expressed in atomic layers is ~30%. Since Al_2O_3 polishing powder is a possible source for at least part of the O contamination, the Al was determined by prompt γ radiation after proton bombardment. (B.L.M.)

40 DETERMINATION OF OXYGEN PRESENT AT THE SURFACE OF METALS BY IRRADIATION WITH 2 MeV TRITONS. Barrandon, J.-N.; Albert , Ph. (CNRS-CECM, Vitry, France). pp 794-801 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

Oxygen was determined on the surface of metals by irradiation with tritons from a Van de Graaff accelerator. The excitation function for the reaction $^{16}O(^3He,n)^{18}F$ was experimentally plotted from 0.5 to 3 MeV. The error in the determination of O is ~10%, and surface O in the range 100 to 10^{-3} $\mu g/cm^2$ can be measured. By use of this method, O was determined in pure Zr and Al samples. The variation of surface O was studied in Zr as a function of chemical and mechanical polishing. (B.L.M.)

41 THE DETERMINATION OF STABLE CALCIUM ISOTOPES BY CHARGED PARTICLE IRRADIATION. Peisach, Max; Pretorius, Rene (Southern Universities Nuclear Inst., Faure, South Africa). pp 802-10 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

Previous sample preparation was necessary prior to irradiation for determination of Ca in biological materials. The Ca was precipitated as the oxalate or carbonate, dissolved in dilute HCl, converted to CaF_2, and evaporated on Ta discs for proton or deuteron irradiation and on Al foils for α activation. Proton and deuteron activations were carried out with a Van de Graaff accelerator and α activation with a cyclotron. The irradiation conditions are specified for each type of irradiation, and the prompt neutrons were measured by the time-of-flight technique. The results of ^{48}Ca and ^{43}Ca determination are tabulated. The relative standard deviation over the concentration range from natural abundance to ~2 at. % was ±2.7% for ^{48}Ca and ±3.2% for ^{43}Ca as determined by proton activation. For deuteron activation, the standard deviation for ^{48}Ca over the same concentration range was ±2%. Alpha activation was unsuitable for determination of Ca tracers, because of the formation of intense activities of ^{43}Sc from ^{43}Ca. (B.L.M.)

42 CROSS SECTIONS OF ^{18}F FORMATION BY DEUTERON BOMBARDMENT OF OXYGEN AND FLUORINE. APPLICATIONS TO OXYGEN ANALYSIS. Tran, Minh Duc; Chenaud, A.; Giron, H.; Tousset, J. (Univ., Lyon). pp 811-18 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

The interaction of O with deuterons to produce ^{18}F has been investigated as an analytical method for the determination of O using a synchrocyclotron for irradiation. The excitation function was determined at 27 MeV. The sensitivity ratios of the O and F analysis were determined for deuterons of various activities, and it was noted that the choice of incident energy may limit the interference and even suppress it. A comparison of O analysis by ^{18}F formation by deuteron and α reactions indicates that the energy requirements to prevent interferences specify which particle shall be used. (B.L.M.)

43 EXAMPLES OF DETERMINATION OF LIGHT ELEMENTS IN VARIOUS HIGH PURITY MATERIALS, BY GAMMA PHOTON AND CHARGED PARTICLE ACTIVATION. Engelmann, Charles; Gosset, James; Loeuillet, Monique; Marschal, Alain; Ossart, Pierre; Boissier, Michele (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). pp 819-28 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

Results are presented for the following analytical determinations: (1) Nondestructive determination of O in Si by α and proton activation; (2) Nondestructive determination of O in Fe and Nb by ^3He activation; (3) O determination by γ activation followed by chemical separation of ^{15}O by reducing fusion; (4) C and N determination in Ta and Ge by γ activation followed by simultaneous separation of ^{13}N and ^{11}C by oxidizing fusion; and (5) N determination by proton activation. The results of the determinations are tabulated, and the importance of certain competitive reactions is shown. From attempts to determine N and B in polycrystalline Si, it was concluded that the proton beam intensity was not sufficient to determine the exact concentration, and deuteron activation was considered more interesting. The lowest amounts of the light elements determinable using these methods, which depend on the type of activation and the intensity, are $\sim 10^{-2}$ for γ activation and 10^{-4} for charged particle activation. (B.L.M.)

44 SELF-SHIELDING CORRECTIONS IN PHOTON ACTIVATION ANALYSIS. Lutz, G. J. (National Bureau of Standards, Washington, D. C. pp 829-34 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

The effect of the difference in absorption of the bombarding particle between sample and standard was considered in high-energy photon activation analysis. Samples of MgO, PbO, and mixtures of the two compounds were irradiated at the NBS LINAC. The count rates/unit wt of Mg and Pb in each sample were calculated and corrected for decay and flux monitor. Data for each element were treated separately, and after calculations, the data were normalized so that the intercept of the line obtained by plotting the natural log of specific activity of the element for each sample against the volume density of the sample corresponding to zero attenuation equals 1 so that a correction factor could be read directly for a desired value of volume density. (B.L.M.)

45 PHOTON ACTIVATION ANALYSIS OF OXYGEN AND CARBON IN A EUTECTIC MIXTURE OF LEAD AND BISMUTH USING A LINAC. Mackintosh, W. D. (Atomic Energy of Canada Ltd., Ontario); Jervis, R. E. pp 835-7 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

Samples of 0.1 cm^3 from a Pb–Bi eutectic mixture circulated through mild steel, Nb, and Zircaloy piping were analyzed for O and C by photon activation and γ spectrometry. Oxide films of known thickness on Mylar, zirconia, and Ta foils were tested as comparative standards. Separate neutron activation experiments were necessary to determine the amount of P present since this would cause interference. ZrO_2 and Mylar foil proved to be the most suitable comparative standards for the O and C determination, respectively. The C content of the samples analyzed ranged from 20 to 40 ppM, and the relative standard deviation of counting statistics was 15%. The sensitivity for C was 5 ppM. The minimum amount of O determined was 3 ± 2 ppM. (B.L.M.)

46 DETERMINATION OF CARBON IN HIGH PURITY IRON BY IRRADIATION IN PHOTONS. Revel, G.; Chaudron, Th.; DeBrun, J. L.; Albert, Ph. (CNRS-CECM, Vitry, France). pp 838-41 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

Carbon was determined in high-purity Fe by photon irradiation to yield ^{11}C, etching the sample in several acid solutions, extracting the C by combustion, and absorbing the resulting CO_2 in soda asbestos. The radioactivity of the ^{11}C was compared to that of graphite standards. The method is also applicable to other very pure metals. (B.L.M.)

47 CHARGED PARTICLE ACTIVATION ANALYSIS FOR CARBON, NITROGEN, AND OXYGEN IN SEMICONDUCTOR SILICON. Nozaki, Tadashi (Inst. of Physical and Chemical Research, Yamoto, Japan); Yatsurugi, Yoshifumi; Akiyama, Nobuyuki; Imai, Itaru. pp 842-6 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

The determination of C, N, and O in semiconductor Si after charged-particle bombardment necessitated the chemical separation of ^{30}P formed from the Si. Oxygen was activated by 15-MeV ^3He bombardment to yield ^{18}F, which was separated from an NaOH-NaF solution of the sample by steam distillation, and then converted to $Pb^{18}FCl$ for counting. Protons of 12-MeV energy were used for activation of N, and 15-MeV ^3He particles were used for C. Disks of graphite, nylon, and SiO_2 covered with Al foils having a thickness equivalent to the sample surface that would be removed by the etching process to remove surface contamination were used as activation standards for C, N, and O, respectively. Concentrations of C, N, and O as low as 10 ppB in semiconductor Si could be determined by this method. (B.L.M.)

48 ^7Be AS A DOSIMETER DURING PHOTON ACTIVATION OF IODINE. Cardarelli, J. A.; Dell, E. S.; Burrows, B. A. (Boston Veterans Administration Hospital, Yale Accelerator, New Haven). pp 847-52 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

Samples of iodine were irradiated with photons in plastic sample tubes at energies of 40 to 50 MeV for the determination of ^{128}I. At this high dose rate at 1 m from the target, ^7Be was produced, and the 0.48-MeV peak of this isotope served as an accurate dosimeter. Samples of iodinated inulin were analyzed. Using a rotation method for the photon activation, the ^7Be photopeak at 0.48 MeV showed a uniform dosimetry within 4%. Potassium iodide samples (100 to 1000 μg I^-) counted in the presence of ^7Be showed variation between duplicates of <5% and linearity of ±1% deviation. The samples of iodinated inulin containing 100 μg I^- were analyzed with 4% variation in the presence of the ^7Be peak without transferring the samples to nonirradiated vessels. (B.L.M.)

49 SOME RECENTLY DETERMINED PHOTONUCLEAR REACTION YIELDS AND CROSS SECTIONS FOR FORMATION OF SEVERAL ISOMERS. Lukens, H. R. (Gulf General Atomic Inc., San Diego, Calif.). pp 853-6 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

Yield values of radionuclides produced by the irradiation of Sr, Y, Ce, Pr, Nd, Er, and Au with 15-MeV (max) bremsstrahlung are presented. Also cross sections for the formation of some metastable isomers by photonuclear excitation are presented. The yield values are tabulated and demonstrate that the various elements examined can be determined with fairly good sensitivity by photonuclear activation analysis using bremsstrahlung. The sensitivities for the elements were: Pr and Sr, <1 μg; Fe, Nd, Er, and Au, 4 to 9 μg; and Y, 40 μg. Cross sections for the formation of metastable isomers by direct photoexcitation of the stable nuclides were computed with respect to the combined intensity of all photons above the energy level of the metastable state, and the results are tabulated. (B.L.M.)

50 SPECTRUM, YIELD, AND USE OF FAST NEUTRONS PRODUCED BY 20 MeV ^3He IONS, 14 MeV PROTONS, AND 7.5 MeV DEUTERONS ON A THICK BERYLLIUM TARGET. Bruninx, E. (Philips Research Labs, Eindhoven, Netherlands). pp 860-7 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

Two procedures are described for the examination of fast neutrons produced on a Be target by 7.5-MeV deuterons, 14-MeV protons, and 20-MeV ^3He ions. A method of threshold detectors was used to determine both the fast neutron spectrum and the fast neutron flux. A sandwich of In, Si, Al, Cu, and C foils was irradiated in a fast neutron beam, and the absolute disintegration rates of the various nuclides formed in the sandwich detector foils were determined by calibration counters. The fast neutron flux was obtained mathematically from the absolute activities. A Cd-shielded paraffin-In detector was used to determine only fluxes or total yields and gives no indication of neutron spectrum. By use of these methods, the results were obtained and are tabulated for the average energy and the maximum energy produced by the particles. The differential spectra are also shown. Experimental total neutron yields are tabulated. In order to obtain an idea of the order of magnitude of the induced activities, the average cross section for a number of nuclear reactions was calculated and is tabulated for comparison. (B.L.M.)

51 THE PRODUCTION OF FAST NEUTRONS BY SMALL CYCLOTRONS. Fleischer, A. A. (Cyclotron Corp., Berkeley, Calif.). pp 868-73 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

The characteristics of some compact cyclotrons are tabulated. The threshold energy and maximum neutron energy for several reactions applicable to activation analysis are tabulated. (B.L.M.)

52 USE OF A 60 MeV LINAC FOR FAST AND VARIABLE ENERGY NEUTRON ACTIVATION ANALYSIS. Wilkniss, Peter E. (Naval Research Lab., Washington, D. C. pp 874-8 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

In activation analysis by high-energy bremsstrahlung produced by interaction of an electron beam of appropriate energy with a high Z element converter, the distribution obtained from a converter, as well as the angular distribution of the photoneutrons, their energy spectrum, and their intensity are discussed. Examples are given for activities obtainable with fast neutron flux. The possibility of variable energy neutron activation analysis is demonstrated by the determination of F according to the reaction $^{19}F(n,\alpha)^{16}N$ in the presence of large amounts of O without interference by the reaction $^{16}O(n,p)^{16}N$. (B.L.M.)

53 BLANK CONSIDERATIONS IN 14 MeV NEUTRON ACTIVATION ANALYSIS FOR TRACE OXYGEN. Nargolwalla, S. S.; Przybylowicz, E. P.; Suddueth, J. E.; Birkhead, S. L. (National Bureau of Standards, Washington, D. C.). pp 879-87 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

The study of blank considerations in neutron activation analysis includes the following: (1) Determination of the attenuation of the activity from the container by samples of different diameters, (2) Definition of a geometrical model that quantitatively expresses the observed attenuation by the samples, and (3) Design of a "flow-through" container for solid samples, which reduces the capsule blank contribution and eliminates the need to encapsulate samples in a N_2 atmosphere provided the propelling gas in the pneumatic system is dry N_2. The solution of these blank problems improves considerably the reliability of the 14-MeV neutron activation technique for the precise and accurate determination of traces of O. The magnitude of errors is greatly decreased with the "flow-through" container for O determination. Also, with improvements in attenuation corrections, the 14-MeV technique compares favorably with other instrumental methods of analysis for O. (B.L.M.)

54 ACTIVATION ANALYSIS OF CHLORIDE AND IODIDE IN PHOTOGRAPHIC EMULSIONS USING 14.7 AND 2.8 MeV NEUTRONS. Przybylowicz, E. P.; Smith, Gilbert W.; Suddueth,

J. E.; Nargolwalla, S. S. (National Bureau of Standards, Washington, D. C.). pp 888-94 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

A nondestructive neutron activation technique for the determination of Cl and I in an AgBr matrix is described. Chlorine is determined in the photographic emulsion by irradiating the sample and a flux monitor, a full capsule of chlorobenzoic acid, in a dual irradiation assembly with fast neutrons, and integrating the Cl peak from 2.75 to 3.30 MeV for both sample and flux monitor. The results of a series of calibration experiments and analyses of two different emulsions are tabulated. The samples for iodine determination were irradiated, along with a capsule of NH_4I as a flux monitor, and the pulses were integrated from 0.4 to 0.5 MeV for the measurement of the iodine. (B.L.M.)

55 LONG TERM OPERATING EXPERIENCE WITH HIGH YIELD, SEALED TUBE NEUTRON GENERATORS. Jessen, F. L. (Kaman Nuclear, Colorado Springs). pp 895-9 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

Laboratory life tests of Type-A-3043 and A-3045 accelerators are described. Life histories of these tubes in actual use are recorded. The data indicate that laboratory life tests simulate actual customer use sufficiently well to allow accurate prediction of accelerator lifetimes that may be expected in field operation. They also indicate that operating periods of a few months may be expected under conditions of relatively high use before changing of the accelerator tube is necessary. (B.L.M.)

56 A 10^{11} NEUTRONS PER SECOND TUBE FOR ACTIVATION ANALYSIS. Downton, D. W.; Wood, J. D. L. H. (Services Electronics Research Lab., Baldock, Eng.). pp 900-4 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

A P-Tube for the production of 10^{11} n/sec is described and illustrated. The life test performance of the tube and its use for activation analysis are also described. The operating parameters of the tube are tabulated. (B.L.M.)

57 A HIGH OUTPUT SEALED-OFF NEUTRON TUBE WITH HIGH RELIABILITY AND LONG LIFE. Reifenschweiler, O. (Philips Research Labs., Eindhoven, Netherlands). pp 905-10 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

A sealed-off neutron tube with an output ranging from several times 10^{10} n/sec to ~10^{11} n/sec with good reliability and a life of more than 1000 hr is described. This tube is applicable to industrial application and was applied to the automatic solution of the following analytical problems: O in steel, O in Zircaloy, O in organic materials, Si in solutions with high Zr concentrations, P in organic materials, Na in Hg, rare earths in Y_2O_3, Hf in Zircaloy, and P in the presence of Si. (B.L.M.)

58 ON-STREAM ACTIVATION ANALYSIS USING SAMPLE RECIRCULATION. Ashe, J. B.; Berry, P. F.; Rhodes, J. R. (Texas Nuclear Corp., Austin). pp 913-17 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

Theoretical considerations of on-stream activation analysis using continuous recirculation of sample between an emitting neutron source and a shielded detector are presented. To evaluate the theory, a taconite ore sample containing ~60% Fe and 5% Si was circulated as an aqueous slurry in a loop. The circulating sample was irradiated with a neutron source (2×10^7 n/sec) and the resulting γ spectra were recorded. The experimental and calculated gain factors are tabulated for comparison. (B.L.M.)

59 FAST NEUTRON CONTINUOUS ACTIVATION ANALYSIS OF DILUTE SOLUTIONS. Jervis, R. E. (Univ. of Toronto); Al-Shahristani, H.; Nargolwalla, S. S. pp 918-24 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

Continuous-flow activation studies were made in 3 aqueous systems: trace F^-, V, and U. Fast neutron activation was used for all 3 studies, but γ counting was done in the first 2 and delayed neutrons in the last. The equipment and procedures are described in detail. In each experiment, the conditions established experimentally for the analysis confirmed the prediction of the computer analyses of the nuclear and flow parameters of the system. The F^- analysis was carried out over the concentration range of 5 to 10%. The sensitivity for V and U was found to be in the order of a few ppM when fast fluxes of 10^{10} or greater were used. (B.L.M.)

60 USE OF VERY SHORT-LIVED NUCLIDES IN NON-DESTRUCTIVE ACTIVATION ANALYSIS WITH A FAST SHUTTLE RABBIT. Wiernik, M.; Amiel, S. (Soreq Nuclear Research Centre, Yavne, Israel). pp 925-8 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

The usefulness of subsecond-half-life radionuclides in activation analysis using a steady-state operating reactor, a shuttle rabbit, and NaI(Tl) scintillation spectrometry was investigated. The special problems of such a study are corrections due to rapidly decaying spectra, deadtime variations, and sensitivities in the presence of different possible interferences. The 0.8-sec ^{207m}Pb isotope was taken as a representative determination for the method. The γ spectra of the irradiated Pb consisted of two peaks, both due to ^{207m}Pb; and the area under the 0.57-MeV peak was used for the assay of the Pb. The results for various Pb determinations in solder, lead glass, and galena are tabulated. When the statistical error of the counts was kept below 1%, the precision of the 5-cycle run was 3 to 4%. (B.L.M.)

61 CYCLIC ACTIVATION ANALYSIS. Givens, W. W.; Mills, W. R. Jr.; Caldwell, R. L. (Mobil Research and Development Corp., Dallas). Contract No. NASw-1435. pp 929-37 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

A mathematical analysis of cyclic activation, description of some experimental studies, and applications of this technique to specific analysis problems are presented. Cyclic activation experiments were performed to verify the theoretical detector response given by the mathematical analysis, to investigate the ^{24}Na 20-msec isomeric activity as a possible alternative to the conventional method using the 15-hr half-life of ^{24}Na for basis of Mg analysis, and to determine what elements commonly found in earth rocks might be subject to analysis by the cyclic activation method. Process control of ores and in situ analysis of geological structures are likely areas where the low-output pulsed-neutron source and cyclic counting of induced activities can be utilized to good advantage. (B.L.M.)

62 AN ANALOG COMPUTER CONTROLLED GAMMA-RAY SPECTROMETER FOR COMPARATIVE ACTIVATION ANALYSIS. Jurs, P. C.; Isenhour, T. L. (Univ. of Washington, Seattle). pp 938-41 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

An apparatus designed to perform real-time comparative activation analysis is described. The instrument directly compares the γ spectra from a standard and a mixed unknown to determine the weight of the desired species in the unknown sample. A block diagram of the apparatus is given. (B.L.M.)

63 DETERMINATION OF TRACE QUANTITIES OF URANIUM IN BIOLOGICAL MATERIALS BY THE NUCLEAR TRACK TECHNIQUE. Carpenter, B. Stephen (National Bureau of Standards, Washington, D. C.). pp 942-5 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

Uranium was determined in blood, plasma, and dried leaves

by putting the biological materials into solution, evaporating known amounts of the solutions on Lexan slides, exposing the material on the slides and standards to neutron irradiation in a reactor, and observing the fission tracks in the samples. Analysis of the blood gave an average value of 86.1 ppB with a standard deviation of 5.6 ppB. The average value of the U content of the mammalian plasma was 60.5 ± 12.0 ppB. (B.L.M.)

64 SURFACE ANALYSIS OF MEDIUM WEIGHT ELEMENTS BY PROMPT CHARGED PARTICLE SPECTROMETRY. Olivier, Colenso; Peisach, Max (Southern Universities Nuclear Inst., Faure, South Africa). pp 946-52 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2) CONF-681003-(Vol.2).

The method using prompt protons from (d,p) reactions was evaluated for the determination of Ni films on Cu and Ta, Cr films on Ni and Ta, and Cu films on Ta. Typical spectra obtained from thin films of Cr, Ni, and Cu on Ta backings and of the protons from the backing itself are presented. The determination of surface Ni on Cu was investigated in most detail. The peaks due to the protons from Ni were readily distinguished from those of Cu. A variation of proton counts for Ni with Ni thickness showed a linear relation up to 100 $\mu g/cm^2$. Results of a typical series of determinations over this thickness region are tabulated, and the standard error was ±2.2 $\mu g/cm^2$ over the whole region. With a bombarding deuteron beam of 3 mm^2 area used with a target inclined at 30° to the beam, the precision attained is equivalent to a relative standard error of ±2.2% on 24 μg of Ni. (B.L.M.)

65 ^{252}Cf: A NEW NEUTRON SOURCE FOR ACTIVATION ANALYSIS. Reinig, W. C.; Evans, A. G. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. pp 953-7 of Modern Trens in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

The characteristics of ^{252}Cf that make it useful as a neutron source are described. A comparison of a 1-Ci neutron source indicated that the emission rate from ^{252}Cf is 300 times as high as from any of the other radionuclide sources. A cost comparison of the sources indicated that the ^{252}Cf source offers the most favorable combination of initial investment plus yearly replenishment costs of an isotopic neutron source. Californium-252 appears to be a good neutron source for activation analysis use in analytical, forensic, hospital, and university laboratories. The high neutron yield from minute sources and their transportability make ^{252}Cf practical for mineral exploration and geophysical studies on land, undersea, or in extraterrestrial environments. (B.L.M.)

66 GAMMA-RAY SPECTROMETRY AND AUTOMATED DATA SYSTEMS FOR ACTIVATION ANALYSIS. Heath, R. L. (National Reactor Testing Station, Idaho Falls, Idaho). pp 959-1031 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

A review is presented of the state-of-art of high-resolution photon spectrometry. The concepts of each element of a modern pulse height analysis system for general laboratory use in high-resolution applications are discussed in some detail. The role of digital-computer-based systems for data acquisition and on-line analysis is discussed. An introduction to the pertinent literature in this area is included, along with some background to supplemental papers on specific applications of high-resolution spectrometry with 34 references being cited. (B.L.M.)

67 COMPARISON OF SOLID STATE AND SCINTILLATION GAMMA-RAY SPECTROMETRY IN ANALYSIS. Voight, Adolf F.; Becknell, Duane E.; Menapace, Laurene (Ames Lab., Iowa). pp 1035-42 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

The Ge(Li) and NaI(Tl) scintillation detectors are compared as to precision in the determination of several elements in the nonstoichiometric W "bronzes" and the analysis of mixtures of rare earths. Results for the determination of K in K-W bronzes and for La in La-W bronzes are tabulated. Binary mixtures of rare earths were analyzed with good precision using the Ge(Li) detectors, but the spectral resolution was not good with a ternary rare earth mixture. No definite conclusions are drawn as to which detector is best, since both seem to have merit in different situations. (B.L.M.)

68 MEASUREMENT AND COMPARISON OF DETECTOR EFFICIENCIES. Dooley, John A. (Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio). pp 1043-8 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

For comparison of efficiencies of NaI(Tl) and Ge(Li) detectors, measurements of a standard source at 2 or more distances from the detector were made, and a plot was made of the inverse square root of the count area as a function of source-detector distance. Two quantities were derived from the plot that together allow computation of efficiency for any source-detector distance including the maximum efficiency attainable by the detector. For the selection of best detector, it is recommended that the efficiency factor and the distance of closest approach for the energy region of interest should be the 2 parameters used in the comparison. (B.L.M.)

69 INSTRUMENTATION FOR COMPUTERIZED NEUTRON ACTIVATION ANALYSIS. Tunnicliff, D. D.; Bowers, R. C.; Wyld, G. E. A. (Shell Development Co., Emeryville, Calif.). pp 1049-53 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

Instrumentation associated with the application of least-squares computer calculations to neutron activation analysis is described. In order to cover the energy scale from 0.05 to 3.0 MeV, a nonlinear energy scale was achieved by use of a "log-compressor," which provides a logarithmic relation at the upper end of the scale and a linear one at the lower end. The log-compressor is located in the circuit immediately following the usual linear amplifier; however, a second linear amplifier is required between the log-compressor and the multichannel analyzer. To maintain stability in the system 3 separate controls, the gain in the system preceding the log-compressor, the gain following the log-compressor, and the zero adjustment in the mult channel analyzer, are provided. A solid NaI(Tl) detector was mounted in fixed geometry to reduce the effects of variation in the amount of sample in the sample container. For rapid readout of spectral data in a form for easy input to a computer, a magnetic tape recorder was coupled to the multichannel analyzer to permit direct dumping of 255 channels of spectral data directly onto a compatible magnetic tape. (B.L.M.)

70 A COINCIDENCE-ANTICOINCIDENCE SYSTEM FOR ACTIVATION ANALYSIS EMPLOYING A SPLIT NaI(Tl) ANNULUS AND A LARGE VOLUME Ge(Li) DETECTOR. Currie, R. L.; McPherson, R.; Morrison, G. H. (Cornell Univ., Ithaca, N. Y.). pp 1062-8 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

A system was devised to permit several simultaneous experiments to be performed using a detector combination with a single multichannel analyzer. A large Ge(Li) detector with very good resolution and high peak-to-Compton ratio was inserted midway into the 3-in.-dia tunnel of an 8-in.-dia by 10-in.-long NaI(Tl) annulus. The source was located on the cryostat window for maximum sensitivity. A block diagram of the electronics of the system is shown. The application of this system to activation analysis of complex systems is described. (B.L.M.)

71 A DUAL CHANNEL ANALYZER AND EFFICIENT COINCIDENCE SYSTEMS FOR ACTIVATION ANALYSIS. Johnson, Ralph A. (Shell Development Co., Emeryville, Calif.). pp 1069-74 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

Systems are described that involve single channel analyzers, coincidence gates, and scalers with readout suitable for data handling by computer. Modifications of the single-channel analyzer are described that convert it into a dual-channel analyzer. An analysis of the different kinds of coincidences encountered with two-photon cascade systems and their relationship to instrumental arrangements, selectivity, and counting efficiencies is presented. (B.L.M.)

72 A COMPTON-SUPPRESSED COINCIDENCE GAMMA-RAY SCINTILLATION SPECTROMETER WITH LARGE NaI(Tl) CRYSTALS. Euler, B. A.; Covell, D. F.; Yamamoto, S. (Naval Radiological Defense Lab., San Francisco). pp 1081-7 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

A Compton-suppressed coincidence γ scintillation spectrometer was assembled to obtain high sensitivity and selectivity in γ spectral measurements. Discussions of detector, photomultipliers, detector mount and shield, amplification and gating circuitry, and pulse-height analyzer are included. The following qualities of the spectrometer were evaluated: (1) resolution, (2) background, (3) degree of Compton suppression, (4) efficiency, and (5) relative sensitivity. The detection system described, when combined with single parameter and 2 parameter pulse-height analyzers, provides as excellent facility for the identification and estimation of low levels of γ radioactivity in a variety of types and sizes of samples containing moderately complex mixtures of γ-emitting radionuclides. (B.L.M.)

73 COMPUTERIZED QUANTITATIVE ANALYSIS OF HIGH-RESOLUTION SPECTRA. Dooley, John A. (Air Force Flight Dynamics Lab., Wright-Patterson Air Force Base, Ohio); Gorrell, James, H.; Polishuk, Paul; Young, Myron. pp 1090-6 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

The Spectral Peak Search and Analysis Computational System (SPSA) was constructed to satisfy the requirements of flexible and convenient input for 4096 channels, location and analysis of peaks, automatic energy calibration, and formatted output including on-line plotted and printed data analysis. The system was constructed in compatible Fortran-IV language. The system will fit into 32 K core storage and only the tape control section is peculiar to the direct-coupled IBM-7094 for which SPSA was designed. A novel parameter card arrangement was designed to minimize user error. (B.L.M.)

74 ON-LINE DATA ANALYSIS OF DIGITAL PULSE-HEIGHT SPECTRA. Trombka, J. I.; Schmadeback, R. L. Goddard Space Flight Center, Greenbelt, Md.). pp 1097-1101 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

A conceptual design and information flow pattern are outlined for a general on-line data analysis system of digital pulse-height spectra. The program was implemented for use on CDC-3200, and details of the programming procedure are included. The on-line computer program is an improved version of the "Linear Least Squares Analysis of Radiation Spectra." (B.L.M.)

75 HEVESY, A COMPUTER PROGRAM FOR ANALYSIS OF ACTIVATION ANALYSIS GAMMA-RAY SPECTRA. Yule, Herbert P. (Texas A and M Univ., College Station). pp 1108-10 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

Data on punched cards in several formats of computer-compatible magnetic tape are read and edited prior to computation with the Hevesy program for γ spectra from activation analysis. The program searches the γ spectrum for peaks, rejecting meaningless statistical fluctuations, Compton edges, and backscatter peaks. For each peak, the program lists the peak energy, the net peak area, the base area, the channels at the extreme right and left sides of the peak, peak width, and standard deviation of the peak area. If the input instructions request it, concentrations of various elements are calculated using the peak area method. The program has the ability to extract correct information from data sets containing invalid information. (B.L.M.)

76 DEVELOPMENT OF A DIRECT CONNECTION BETWEEN AN ACTIVATION ANALYSIS LABORATORY AND AN IBM 360/65 COMPUTER. Girardi, F.; Guzzi, G.; Di Cola, G.; Becker, W.; Termanini, A. (CCR, Ispra, Italy). pp 1111-15 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

A system for direct connection between an activation analysis laboratory and an IBM 360/65 computer consists of an IBM Telecommunication system installed in the counting room and connected by a coaxial cable to the main computer. An interface, a digital entry system, and an electronic clock complete the system. A block diagram of the system is presented, and the operation of the system is described. (B.L.M.)

77 DEVELOPMENTS IN THE USE OF SMALL DIGITAL COMPUTERS IN ACTIVATION ANALYSIS SYSTEMS. Pierce, T. B.; Webster, R. K.; Hallett, R.; Mapper, D. (Atomic Energy Research Establishment, Harwell, Eng.). pp 1116-20 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

A system used extensively for reactor activation analysis includes a PDP-8 computer used for direct data acquisition, e.g., as a γ spectrometer and for calculations in its own right. The system also includes 2 magnetic tape units, electronic units, and a 30-cm^3 coaxial Ge(Li) detector coupled with a room-temperature field effect transistor preamplifier. This system provides an overall resolution of 5 keV for γ spectrometry. The system has been used for a number of analytical analyses, which are listed. (B.L.M.)

78 ON-LINE ACTIVATION ANALYSIS WITH A PDP-9 COMPUTER. Thompson, C. J. (Atomic Energy of Canada Ltd., Ottawa). pp 1121-6 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

An activation analysis system for routine quantitative measurements of a few elements in many samples on a continuous basis and for rapidly analyzing complex spectra to find the elements present in unknown samples was set up at Atomic Energy of Canada Limited. The system includes an Sb-Be thermal neutron source with a flux of up to 7×10^8 n/cm^2/sec, a PDP-9 computer that is used to acquire and analyze spectra, and a fast pneumatic sample changing system. The computer program, SPECTRUM-40, is explained in some detail as is the operation of the system. (B.L.M.)

79 MAN-MACHINE INTERACTION IN ANALYSIS OF PULSE-HEIGHT SPECTRA. Burrus, Walter R. (Tennecomp, Inc., Oak Ridge, Tenn.). pp 1127 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

80 NBS AUTOMATED ACTIVATION ANALYSIS INFORMATION RETRIEVAL SYSTEM. Lutz, G. J.; Boreni, R. J.; Maddock, R. S.; Meinke, W. W. (National Bureau of Standards, Washington, D. C.). pp 1128-30 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

A computer storage and retrieval information system for literature on activation analysis at NBS is described. Each item in the file is coded to each (if appropriate) of 5 main categories: element determined; matrix analyzed; technique used; nature of publication, language, and country of origin; and scope of publication. After an item is indexed, its accession number, authors, literature citation, year of publication, and keys of classification are punched on paper tape for storage on magnetic tape. Searches may be made on the basis of classification, authors, and year of publication. (B.L.M.)

81 EDGE-PUNCHED CARD LITERATURE RETRIEVAL SYSTEM FOR ACTIVATION ANALYSIS. Braun, T. (L. Eotvos Univ., Budapest); Bujdoso, E.; Miskei, M. pp 1131-7 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

An activation analysis literature card system (AALC) was set up using edge-punched cards with all the explications printed on each card to provide documentation of the ever-expanding literature. All the data necessary for the identification and retrieval of the publication and as many data on the contents of the publication as possible appear on the card. The design of the actual punched card is described. Both a simple and a complex example for the use of the system is given, and a listing is made of the types of problems on which the system is suitable to render information. (B.L.M.)

82 ISOTOPES INFORMATION CENTER. Baker, P. S. (Oak Ridge National Lab., Tenn.). pp 1138-43 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

The scope and operations methodology of the Isotopes Information Center at ORNL are explained. Both input and output of the center are discussed. An appendix to the paper gives a list of subject headings included by the center for information storage and retrieval. (B.L.M.)

83 COMPUTERIZED IDENTIFICATION OF REACTOR-PRODUCED ISOTOPES. Dooley, John A. (Air Force Flight Dynamics Lab., Wright-Patterson Air Force Base, Ohio); Gorrell, James H.; Thompson, James M.; Hoffman, Edward. pp 1148-53 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

A computer program, Isotopes Library Identification Program, (ILIP) was set up to use photopeak energies found in an unknown spectrum and to logically determine which isotopes are present in an unknown sample after reactor activation. The photopeak energies from the spectrum are compared to an energy-isotope list. The ILIP analysis system comprises the card library, 2 tape generating programs, and the Isotope Library Identification program and is illustrated in a block diagram. All subroutines in the program are in FORTRAN-IV coding and should run on any machine using this language. An example of using the system to identify the components for a synthetic composite sample is given. (B.L.M.)

84 COMPUTATION OF EXPERIMENTAL RESULTS IN ACTIVATION ANALYSIS. Yule, Herbert P. (Texas A and M Univ., College Station). pp 1155-1204 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

Experimental procedures in activation analysis that lead to and produce the counting data are reviewed briefly. A number of ways in which counting data are treated are described. Some preliminary type remarks on the processing of large numbers of samples including ramifications of data processing are then made. The early history of activation analysis showing the development of computerized methods as new instruments have emerged is reviewed with considerable detail to the computation methods appearing prior to 1962. A detailed description of today's most prevalent computation methods with an indication of how various researchers have improved the accuracy of the computed results for each method is presented. The author presents his critiques of present day computation methods with comments on accuracy, errors, and outright failures of an individual method. A final section of this paper surveys the possible future developments. (B.L.M.)

85 COMPUTER ANALYSIS OF GAMMA-RAY SPECTRA: VALIDITY OF THE RESULTS. Lucas, Henry F. Jr.; Edgington, David N. (Argonne National Lab., Ill.). pp 1207-14 of Modern Trends in Activation Analysis. Vol. II. Devoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

Some consideration is given as to whether errors in results from computer analysis of γ spectra arise from incorrect questioning concerning the input data and the results. Data for analysis were obtained with a 4 × 2 in. NaI(Tl) crystal with 6% resolution for ^{137}Cs. All calculations were performed with an iterative, weighted, least-squares program on a CDC-3600 computer. The source of errors is discussed under the following headings: evaluation of errors in input data, zero counts in a channel, evaluation of residuals, and geometrical effects. (B.L.M.)

86 THE DISCOVERY OF ERRORS IN THE DETECTION OF TRACE COMPONENTS IN GAMMA SPECTRAL ANALYSIS. Currie, Lloyd A. (National Bureau of Standards, Washington, D. C. pp 1215-19 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

The problems of limits of decision, detection, and determination were investigated with respect to trace components. For γ spectral analysis if a model chosen is too simple, there is danger of missing a trace component; however, this component may contribute an error to the determination of another component. Systematic errors can be enormous in this case, while the popular fit-statistics may appear perfectly satisfactory. Other types of errors are also considered. (B.L.M.)

87 REGRESSION ANALYSIS OF GAMMA-RAY SPECTROMETER DATA WITH AN APPLICATION TO THE ASSAY OF HUMAN RADIOACTIVITY BURDENS. Pasternack, Bernard; Harley, Naomi (New York Univ. Medical Center). Contract AT(30-1)-3136. pp 1220-30 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

A regression method, which permits correction for gain and baseline discrepancies between reference and mixture pulse-height distributions of spectral analysis is based upon iteratively transforming reference pulse-height distribution until a best least squares regression fit is obtained. This method of data analysis was applied to total body counting. A woman who had been a Ra dial painter was counted on 4 separate occasions. The results of the computer analysis for ^{226}Ra, ^{40}K, and ^{137}Cs are tabulated. (B.L.M.)

88 COMPUTER GAIN CHANGING OF SCINTILLATION SPECTRA. Steyn, J. J. (NUS Corp., Washington, D. C.); Andrews, D. G. pp 1231-7 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

A digital-computer gain changing code (GANE) developed during the course of some experimental research into γ photon backscattering as an aid in the computer analysis of spectra is described. The program is designed primarily around a sequence of logical steps, viz. an algorithm, which is described in some detail. The code written in a general FORTRAN language is readily usable on most computers without modification. (B.L.M.)

89 QUANTITATIVE ANALYSIS OF UNKNOWN MIXTURES BY COMPUTER REDUCTION OF Ge(Li) SPECTRA. Gunnink, Ray; Niday, J. B. (Univ. of California, Livermore). pp 1244-5 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

Computer programs capable of accurate reduction and interpretation of γ spectra of mixtures from a Ge(Li) detector in use at Lawrence Radiation Laboratory were modified for the treatment of unresolved peak interferences in the final calculations of the disintegration rates of the various components. A brief summary of the data reduction sequence is given. (B.L.M.)

90 COMPUTER-BASED SYSTEM FOR NEUTRON ACTIVATION ANALYSIS. Tunnicliff, D. D.; Wyld, G. E. A. (Shell Development Co., Emeryville, Calif.). pp 1246-9 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

The stepwise regression program for both qualitative and quantitative analysis of mass spectrometric data was applied to neutron activation data. The program makes use of spectral data for as many as 6 decay times. The approach is quite general and no special development is required for a new mixture pro-

vided all the necessary reference spectra are available and the original assumptions for mathematical interpretations remain valid. The computer program is so designed that any element may be used as an internal standard. Since a library of reference spectra used for the calculations must include the spectrum of every significant radioisotope present in the sample measured in the same geometry with the same detector as the sample, a separate computer program was developed for computing these reference spectra using data obtained from a single radioisotope or for a mixture. The program also includes, as an option, an iterative procedure to determine the half-life of each radioisotope that gives the best fit of the computer spectra to the observed spectra. The program was only applied to samples irradiated with thermal neutrons. (B.L.M.)

91 RAPID MANUAL RESOLUTION OF MULTI-COMPONENT GAMMA-RAY PHOTOPEAKS. Lukens, H. R. (Gulf General Atomic Inc., San Diego, Calif.). pp 1251-5 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

A method for manually resolving overlapping peaks in a complex spectra recognizes the histogram nature of the data and assumes a normal probability of distribution. The calculation involves only one basic equation and the Table of Normal Curve of Error (TNCE). Three experiments were carried out to illustrate the use of the method. These were: (1) experiments to illustrate the simplicity and ease with which single components of composite photopeaks may be obtained by either the single equation or simultaneous equation method; (2) an experiment to illustrate a variation in which TNCE is not required; and (3) an experiment to illustrate the analysis of a peak that might appear to have only one component. Some results are tabulated. (B.L.M.)

92 COMPUTER STUDIES OF COMPLEX FULL ENERGY PEAKS USING SECOND AND THIRD DERIVATIVES. Yule, Herbert P. (Texas A and M Univ., College Station). pp 1256-9 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

Adaptation of the simplified least squares data convolution technique to studies of complex Ge(Li) detector peaks with the smoothed second and third derivatives is reported. Complex spectra of ^{51}Cr were studied. A number of questions remain about the application of this method of detecting complex peaks. These questions, which are currently under study are: (1) how does the implementation of the smoothing-differentiating computation affect results? (2) how sensitive is the method for small contributors to large peaks? (3) how reliable is the method for small complex peaks? (4) what is the role of statistical fluctuations in terms of reliability and sensitivity? (B.L.M.)

93 THE PRECISION OF MULTI-ELEMENT TECHNIQUES IN ACTIVATION ANALYSIS. Coleman, R. F. (United Kingdom Atomic Energy Authority, Aldermaston, Eng.). pp 1262-7 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

The precision of analysis of known mixtures was determined by 3 activation methods and also by the more practical test involving the analysis of a glass sample with more than 20 detectable components. The 3 methods of analysis studied were: (1) γ spectrometry with NaI detector, (2) γ spectrometry with Ge detector, and (3) γ spectrometry after automatic group separation. The results of the determinations are tabulated. It was concluded that the use of group separation, which can be readily automated, is the best compromise available to the methods tested, and that it permits multielement analysis of a wide variety of samples with good precision. (B.L.M.)

94 CONTRIBUTION TO IMPROVEMENTS IN ACCURACY AND REPRODUCIBILITY OF ROUTINE ACTIVATION ANALYSIS. Dugain, F. (Centre de Recherches du Groupe Pechiney, Voreppe, France). pp 1268-78 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

Some factors were studied that appeared to relate to random errors in activation analysis. Two sources of errors are error in weight of a reference solution and error in flux during irradiation. Experiments are described to determine the maximum of certitude about the value of each standard used in routine analysis and to arrive at an estimation of the flux depression and a practical way to compensate its effect. Evaluation of the magnitude of both these errors plus an error of <1% due to a chemical separation on a resin as used in the tests led to a value of ~3% for the overall error. Analysis of various samples was tabulated and the results seemed to confirm conclusions drawn concerning accuracy and reproducibility. (B.L.M.)

95 PRECISION IN THE NEUTRON ACTIVATION ANALYSIS FOR GOLD IN STANDARD ROCKS G-1 AND W-1. Fritze, K.; Robertson, R. (McMaster Univ., Hamilton, Ont.). pp 1279-83 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

A tabulation of a number of results of activation analysis for Au in NBS standards rocks G-1 and W-1 indicate generally poor agreement. The present work was undertaken to determine whether this disagreement was due to nonhomogeneous distribution of Au in the rocks. Large samples (200 mg) of each rock were irradiated; and after a 3-day cooling period, 8 small aliquots were taken from each sample and weighed accurately. An Au carrier was added, and the Au in each sample was precipitated as the metal. After filtration, the γ spectrum of each sample was recorded. Results of the experiment are tabulated, and it is evident that the Au is not distributed homogeneously. Various ideas are advanced to explain this situation. (B.L.M.)

96 HIGH PRECISION ACTIVATION ANALYSIS OF SODIUM USING AN INTERNAL STANDARD TECHNIQUE. Marsh, R. H.; Allie, W. Jr. (Ford Motor Co., Dearborn, Mich.). pp 1284-90 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

A method was developed for the determination of Na in materials, which can be readily solubilized only by a basic fusion, by neutron activation using As as an internal standard. Results for Na were obtained by plotting out spectra, subtracting out the background blanks, correcting for decay, and calculating the Na_2O. Two major sources of error, flux variations due to nonhomogeneity of the samples and error in subtracting out the pure Na and As background blanks are discussed in detail. A comparison of neutron activation analysis and atomic absorption results is tabulated as are results for determination of Na_2O in Al_2O_3 on thin films. Ceramic samples have been analyzed on a routine basis using this method without a digital spectrum stabilizer or total peak integration. The standard deviation of a single determination was consistently within 1.5%. The results for the ceramic samples are tabulated. (B.L.M.)

97 NBS STANDARD REFERENCE MATERIALS AVAILABLE FOR ACTIVATION ANALYSIS. Meinke, W. Wayne; Cali, J. Paul (National Bureau of Standards, Washington, D. C.). pp 1291-3 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

National Bureau of Standards standard reference materials available or soon to be available for activation analysis are discussed and the assays given. Steels and brasses, neutron flux wires, and high-purity metal standards are discussed. (B.L.M.)

98 THE ROLE OF ACTIVATION ANALYSIS IN THE NBS STANDARD REFERENCE MATERIAL PROGRAM. Cali, J. Paul (National Bureau of Standards, Washington, D. C.). pp 1294-7 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

The role of activation analysis in the NBS standard reference material (SRM) program is assessed as to uniqueness, utility, advantages, and disadvantages. In the certification of 2 recent SRM's, high-purity Zn and Pt, several elements could not have

been listed without activation analysis. Oxygen content of several SRM's was determined by fast neutron activation analysis and provides an alternate analysis to vacuum fusion determinations. Activation analysis is now under consideration for use in certification of 17 SRM's. (B.L.M.)

99 AN OXYGEN STANDARD FOR THE DETERMINATION OF OXYGEN IN STEEL BY 14 MeV NEUTRON ACTIVATION ANALYSIS. Gijbels, R.; Speecke, A.; Hoste, J. (Ghent Univ.). pp 1298-1305 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

A relative method for routine determination of O in steel by 14-MeV neutron activation analysis by comparison with a standard of known O content is reported. The standards used were capsules of ordinary steel machined to certain dimension with a mixture of spectrographic pure graphite + Fe_2O_3. The mixture was pressed into the capsule at 1000 psi in 7 portions. The results obtained for the O content of the standards are tabulated and indicate that the standards are identical and symmetrical. The standards and system of analysis described were used in a steel plant in Belgium since February, 1967 with sufficiently reproducible results to warrant continual use. The results of the activation analysis are computed automatically and agree satisfactorily with those obtained by various carburizing fusion methods. (B.L.M.)

100 HIGH PURITY CELLULOSE AS A POSSIBLE BIOLOGICAL REFERENCE MATERIAL. Rancitelli, L. A.; Tanner, T. M.; Haller, W. A. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. pp 1306-10 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

Trace element analysis by direct instrumental neutron activation of high-purity cellulose filter is presented to demonstrate the homogeneity and purity of the material. An analytical technique, which permits trace element measurement at very low concentrations with good precision, is described. Samples of cellulose filter material IPC No. 1478 obtained from Knowlton Bros., Watertown, N. Y., both untreated and treated with Kronisol (dibutoxyethyl phthalate) as a part of the manufacturing process were analyzed. Appropriate flux monitor standards were also irradiated. The results of the analyses of both treated and untreated materials are tabulated for comparison with each other and with results for a very pure sample of kale proposed previously for a biological standard. (B.L.M.)

101 MICROSTANDARDS FOR ACTIVATION ANALYSIS. Freeman, David H. (National Bureau of Standards, Washington, D. C.). pp 1311-16 of Modern Trends in Activation Analysis. Vol. II. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.2).

The theory, preparation, and evaluation of ion-exchange-resin single beads loaded with an ion or ions for use as microstandard in activation analysis are discussed. Either N or S on the bead in the exchange group can serve as an internal standard. Various advantages for use of the bead standards are presented. (B.L.M.)

102 ACTIVATION ANALYSIS FOR MOLYBDENUM IN SAMPLES CONTAINING LARGE AMOUNTS OF TUNGSTEN. Thompson, Barbara A.; LaFleur, Philip D. (National Bureau of Standards, Washington, D. C.). Anal. Chem., 41: 1888-9 (Nov. 1969).

The 0.142 MeV γ ray of ^{99m}Tc is measured in the neutron activation determination of Mo. For Mo determination in the presence of W, a method was developed involving separation of ^{99m}Tc. After irradiation of a Mo-W alloy, it was dissolved in HF-HNO_3 mixtures, Mo extracted with DEHPA and set aside for 24 hr to allow ^{99m}Tc to grow in. The technetium is then extracted with nitric acid and counted. (M.C.G.)

103 DETERMINATION OF RHENIUM IN GERMANIUM BY NEUTRON ACTIVATION. Razumova, G. N.; Shuba, I. D. Radiokhimiya, 11: 354-6(1969). (In Russian).

A method is proposed for the determination of rhenium in almost pure germanium by isolation of this element on the chloride form of the AB-17 resin and neutron activation. The yield of rhenium was 95%. The sensitivity of the determination is 4×10^{-8} g. (M.C.G.)

104 MODERN TRENDS IN ACTIVATION ANALYSIS. VOLUMES I AND II. Proceedings of the 1968 International Conference Held at the National Bureau of Standards, Gaithersburg, Maryland, October 7-11, 1968. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969. 1362p. (NBS-Spec. Publ.-312(Vol.1); NBS-Spec. Publ.-312(Vol.2); CONF-681003-(Vol.1); CONF-681003-(Vol.2)). GPO $8.50.

The conference proceedings are divided into 2 volumes. Volume 1 includes 2 sections: applications in activation analysis and radiochemical separations. Volume 2 has 3 sections: neutron, photon, and charged-particle reactions for activation analysis; gamma spectrometry and automated data systems for activation analysis; and computations of experimental results in activation analysis. Each section begins with a plenary lecture and each chapter with a discussion synopsis. Separate abstracts were prepared for 148 of the 159 papers. The remaining eleven papers were previously abstracted for NSA. For abstract numbers see CONF-681003 in the Report Number Index. (B.L.M.)

For abstracts of individual papers see: 24-101, 105-173, and 292.

105 ACTIVATION ANALYSIS IN THE CONTEMPORARY WORLD. QUESTIONS AND ANSWERS. Lenihan, J. M. A. (Western Regional Hospital Board, Glasgow). pp 1-32 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

The characteristics, achievements, limitations, and potentialities of activation analysis are reviewed against the changing background of contemporary science and technology. The costs of activation by various bombarding particles and the activation processes associated with each of these particles are discussed. The discussion of scope and applications of activation analysis is restricted to the following 6 aspects of the environment: (1) cosmic, (2) geological, (3) biological, (4) internal biological, (5) artificial, and (6) social. Examples of the uses of activation analysis in each aspect are discussed. (B.L.M.)

106 THE HALOGEN COMPOSITION OF AEROSOL PARTICLES OVER LAKE MICHIGAN. Loucks, Ronald H.; Winchester, John W.; Matson, Wayne R.; Tiffany, Mary A. (Univ. of Michigan, Ann Arbor). pp 36-42 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Samples were taken above the surface of Lake Michigan from the deck of a research vessel for activation analysis to determine the air pollution from coastal locations, particularly the Chicago-Gary urban and industrial complex. The results of halogen determination in the aerosols by activation analysis are tabulated and compared with data from Fairbanks, Alaska and Hawaii. No evidence was found for air pollution by iodine, but anomalously high concentrations of both bromine and chlorine were detected in the urban localities. (B.L.M.)

107 THERMAL NEUTRON ACTIVATION ANALYSIS OF AIRBORNE PARTICULATE MATTER IN CHICAGO METROPOLITAN AREA. Brar, S. S. (Argonne National Lab., Ill.); Nelson, D. M.; Kanabrocki, E. L.; Moore, C. E.; Burnham, C. D.; Hattori, D. M. pp 43-54 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Thermal neutron activation analysis for airborne particulate matter in the Chicago area was carried out on samples collected at 22 different locations on cellulose-base filter papers. The following trace elements were determined using NaI(Tl) crystal γ spectrometer: Br, Mn, V, Al, Cl, Na, Hg, S, Ca, Cr, Zn, Fe, Sb, Sc, and Co. (B.L.M.)

108 APPLICATION OF ACTIVATION ANALYSIS AND Ge(Li) DETECTION TECHNIQUES FOR THE DETERMINATION OF STABLE ELEMENTS IN MARINE AEROSOLS. Dudey, N. D. (Argonne National Lab., Ill.); Ross, L. E.; Noshkin, V. E. pp 55-61 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

The feasibility of elemental analysis of airborne particulate matter by neutron activation and Ge(Li) detectors was investigated. Concentrations of 20 trace elements in marine aerosols are reported, and suggestions for improvement of the technique are given. The sampling locations, dates, and volumes of air/sample are tabulated. The elements determined were Ce, La, Sm, Eu, Tb, Yb, Hf, Sc, Cr, Fe, Co, Cu, Zn, Ga, Se, In, Sb, Cd, Au, and Hg, and the accuracy of the method was ±15%. (B.L.M.)

109 MEASUREMENTS OF MOVEMENTS OF SOLID SUBSTANCES IN WATER BY MEANS OF STABLE TRACERS AND ACTIVATION ANALYSIS. Cappadona, Carmelo (Univ., Palermo, Italy). pp 72-5 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

The movements of sands on the Mondello Beach, Palermo, Sicily were studied with Ag and Co stable isotope tracers and neutron activation analysis. A sample of sand was treated with about 15% stable tracer and scattered in the sea along the beach. After some time samples were taken along the coast and analyzed for Ag by activation analysis. (B.L.M.)

110 SPECIFIC ACTIVATION ANALYSIS TECHNIQUES AND METHODS FOR THE ASSAY OF TRACE SUBSTANCES IN AQUATIC AND TERRESTRIAL ENVIRONMENTS. Leddicotte, G. W. (Univ. of Missouri, Columbia). pp 76-80 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Samples of water, soil, stream sediments, dust, vegetation, and similar materials from aquatic and terrestrial environments were analyzed by activation analysis for unusual, as well as common, elements. These studies were particularly concerned with the potential hazards and significance of the elements as environmental pollutants when used as pesticides or fungicides, catalytic or excitation agents, or as part of an industrial process. Copper, Mn, Cl, Al, Fe, Zn, Se, Th, Co, and Cs were determined in deep spring waters. Chlorine, Br, Cu, Mn, Ba, Sr, and Na were determined in raw industrial water and Br, Cu, and Mn in industrial waters after deionization. Chlorine was determined in chlorine pesticide residues; and pesticide residues, as measured by Cl, Br, Mn, Mg, and Cu, were determined in vegetation. Cerium, La, Sc, and Th were determined in soil samples. (B.L.M.)

111 POST-SAMPLING ACTIVATION ANALYSIS OF STABLE NUCLIDES FOR ESTUARY WATER TRACING. Channell, J. K.; Kruger, P. (Stanford Univ., Calif.). pp 81-6 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Stable, high-neutron-capture-cross-section rare earth elements were investigated as external tracers in estuarine waters by activation analysis. The procedures reported for open-ocean analysis were used to separate rare earth elements as a group from estuarine water samples to prevent interference from large suspended sediment and biological concentrations. Carrier free ^{88}Y was added as a tracer. From studies with artificial seawater chemical yield of tracers averaged 60 to 70% before activation. Experimental variables and the natural background concentration for La and Eu were determined in the San Francisco Bay estuary. (B.L.M.)

112 NEUTRON ACTIVATION ANALYSIS OF VANADIUM IN NATURAL WATERS. Linstedt, K. D. (Univ. of Colorado, Boulder); Kruger, Paul. pp 87-92 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Vanadium was determined in natural waters by γ spectrometry of ^{52}V after thermal neutron irradiation. For river waters, the major interferences were from that of 15-hr ^{24}Na and 37.3-min ^{38}Cl. The V concentration in natural water samples ranged from a low value of 0.2 μg/l to 49.2 μg/l with a standard deviation of ±10% at 1.0 μg/l and ±1% at 10 μg/l. (B.L.M.)

113 NEUTRON ACTIVATION ANALYSIS IDENTIFICATION OF THE SOURCE OF OIL POLLUTION OF WATERWAYS. Guinn, V. P.; Bellanca, S. C. (Gulf General Atomic, Inc., San Diego, Calif.). pp 93-7 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

A method is described for determining the origin of a given pollution event in which freshwater, brackish water, or seawater is polluted, accidentally or intentionally, by heavy oil. A summary of the nature and importance of the oil pollution problem is presented. Sixteen different marine fuel oils were analyzed by neutron activation analysis, and their V, Mn, Na, Co, Sb, As, Cu, and Zn concentration levels are compared. The prolonged effects of seawater on these trace-element concentrations were explored. (B.L.M.)

114 MULTIELEMENT ANALYSIS OF PATHOLOGICAL TISSUE. Linekin, D. M.; Balcius, J. F.; Cooper, R. D.; Brownell, G. L. (Massachusetts General Hospital, Boston. Army Natick Labs., Boston). pp 110-13 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

A method for multielement (Sn, Hg, Cd, Cr, Au, Sb, Br, Ag, Rb, Fe, Zn, and Co) analysis of biological samples by neutron activation is described. Trace element content of the lung of a man who died with a lung disease resembling asbestosis or silicosis was compared with normal tissue; it showed Br and Zn contents in the fibrotic parenchyma greater than in normal parenchyma but showed lower Rb and Fe than in the normal one. Trace element levels in the blood, heart, and diaphragm of a Syrian golden hamster with a dystrophy-like myopathy were compared with measurements on a normal hamster. The results of trace element measurements in two types of experimental mouse tumors are presented. (B.L.M.)

115 THE USE OF NEUTRON CAPTURE GAMMA RADIATIONS FOR THE ANALYSIS OF BIOLOGICAL SAMPLES. Comar, D.; Crouzel, C.; Chasteland, M.; Riviere, R.; Kellershohn, C. (Frederic Joliot Hospital, Orsay, France). pp 114-27 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

A method and apparatus are described for the determination of H, Cl, N, K, Na, B, S, Fe, P, and Ca in blood, bone, hair, and plant tissue by γ spectra following neutron irradiation. The capture γ-spectra of both calcined and noncalcined blood samples are recorded. The sensitivity of the method is estimated at 1 μg for B, 1 mg for Cl, and ~10 to 20 mg for H; and the results obtained by the method are comparable with those obtained by other methods. Since the emission of capture γ rays is independent of both the physical and biological half-lives, the method is applicable to the in vivo determination of Ca, Na, and Cl in bone. (B.L.M.)

116 ELEMENT IMBALANCES OF ATHEROSCLEROTIC AORTAS. Strain, W. H. (Univ. of Rochester, N. Y.); Rob, C. G.; Pories, W. J.; Childers, R. C.; Thompson, M. F. Jr.; Hennessen, J. A.; Graber, F. M. pp 128-33 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Activation analyses were carried out on normal and atherosclerotic aorta from rats and man for the determination of Ca, Cd, Co, Cu, Mg, Mn, Se, V, and Zn, since these elements seem to be important to arterial metabolism. The samples were irradiated at a thermal neutron flux of 1.8×10^{12} n cm^{-2} sec^{-1}, and the radiochemical separations were carried out by precipitating insoluble phosphates and sulfates and extracting soluble complexes of diethyldithiocarbamic acid in ethyl acetate at various pH levels. The analytical results are tabulated and show that there are significant differences in element content between normal and atherosclerotic tissue. As the degree of atherosclerosis increased, the element content in ppM changed as follows: Ca from <350 to 170,000; Cd from undetectable to 0.34; Mg from <110 to 880; Mn from 0.081 to 1.9; Se from <0.4 to 0.6; and Zn from 30 to 152. The changes in Cu were inconsistent, and V could not be detected. The data seem to support the use of Zn therapy in the treatment of artherosclerosis occlusive disease. There are some indications that the human diet may be inadequate in available Zn if artherosclerosis develops. (B.L.M.)

117 A USEFUL NEUTRON ACTIVATION ANALYSIS METHOD FOR THE DETERMINATION OF TELLURIUM IN HUMAN TISSUES. Abu-Samra, A.; Leddicotte, G. W. (Univ. of Missouri, Columbia). pp 134-7 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Samples of tissue were irradiated by thermal neutrons according to the nuclear reaction, $^{130}Te(n,\gamma)^{131}Te \xrightarrow{\beta^-} {}^{131}I$, and then destructive distillation was used to free the ^{131}I (8.05-day) and the I^- carrier from interferences of ^{24}Na, ^{64}Cu, ^{56}Mn, and other radioactive species produced in samples during activation. The ^{131}I and carrier were removed from the distillate by solvent extraction with chloroform and then precipitated as AgI. After correcting for chemical yield and taking the ratio of the counts of ^{131}I from both sample and standard, the concentration of Te in the tissue was obtained, and the results tabulated for both hard and soft tissue. (B.L.M.)

118 NEUTRON ACTIVATION ANALYSIS OF BRAIN FOR COPPER AND MANGANESE. Bird, Edward D. (Bowman Gray Medical School, Winston-Salem, N. C.); Emery, J. F.; Lupica, S. B.; Lyon, W. S. pp 138-41 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Animals were treated with phenothiazine for variable time periods and then sacrificed for activation analysis of the basal ganglia for Mn and Cu. After digestion with acids, the samples were passed through small columns of Sb_2O_5 preconditioned with 9N HNO_3, and the eluate was counted in a multichannel analyzer. Typical γ spectra taken before and after the Sb_2O_5 separations are shown. A significant increase in the Mn concentration was noted for animals treated for 1 month, but no significant difference in Mn concentration when animals were treated for longer periods up to one year was noted. The Cu concentration was not measured in control animals. (B.L.M.)

119 NEUTRON ACTIVATION ANALYSIS OF BARNACLE SHELLS. Gordon, C. M.; Larson, R. E. (Naval Research Lab., Washington, D. C.). pp 142-6 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Neutron activation analysis with computer analysis of the resultant γ spectra was used to determine the effect of salinity on the deposition of Ca, Mg, Mn, Sr, and Na in barnacle shells. The shells studied were collected from various sites along the shores of Chesapeake Bay. The Mn content of the shells was found to vary inversely as the salinity of the aquatic habitat. A large variation was noted for the Mn/Ca ratio among the 4 species studied. No measurable correlation between Sr concentration and salinity was observed. For some species studied, there was a positive correlation between Na and salinity and a negative correlation between Mg and salinity. (B.L.M.)

120 SAMPLING METHODOLOGY DEVELOPMENT IN A LARGE SCALE CYSTIC FIBROSIS SCREENING PROGRAM BASED ON AUTOMATED NEUTRON ACTIVATION ANALYSIS. Fite, L. E. (Texas A and M Univ., College Station); Wainerdi, R. E.; Yule, H. P.; Harrison, G. M.; Bickers, G.; Doggett, R. pp 147-55 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

A large-scale screening program of newborn infants in Texas hospitals for cystic fibrosis as indicated by high Na content of nail clippings analyzed by neutron activation and computer analysis of the γ spectra is described. Sampling difficulties, sample contamination, and possible pre-cleaning techniques prior to sampling are described. (B.L.M.)

121 CLINICAL EXPERIENCE WITH THE USE OF NEUTRON ACTIVATION ANALYSIS IN THE DIAGNOSIS OF CYSTIC FIBROSIS. Woodruff, Gene L. (Univ. of Washington, Seattle); Wilson, William E. Jr.; Yamamoto, Yuki; Babb, Albert L.; Stamm, Stanley J. pp 156-9 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Nail samples from both controls and cystic fibrosis patients were analyzed for Na, K, and Cl by neutron activation and beta and γ counting. The measurement of Na is a useful supplement to other diagnostic results, but alone it is probably not a sufficient basis for a successful screening technique. Measurement of the Na : K ratio helps detect false positives caused by gross Na contamination. The Na concentration was found to be a function of age with the maximum occurring at birth and sometimes decreasing by a factor of 2 within the first 72 hr. (B.L.M.)

122 DETERMINATION OF VANADIUM BY NEUTRON ACTIVATION ANALYSIS AT NANOGRAM LEVELS IN DIETS FOR EXPERIMENTAL ANIMALS. Lambert, J. P. F.; Simpson, R. E. (Food and Drug Administration, Washington, D. C.). pp 170-6 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Vanadium at nanogram levels was determined by neutron activation and radiochemical separation in the diets of animals and individuals. At nanogram levels, the sensitivity of the method is a factor of the separation time, the chemical procedure, and the sample matrix. By use of this method, a precision of ~30% was feasible at a 95% confidence level. Cr and Mn interfere with the determination. The results of analyses on diets for experimental animals and on several dietary constituents for individuals are tabulated. (B.L.M.)

123 THE INSTRUMENTAL DETERMINATION OF FIFTEEN ELEMENTS IN PLANT TISSUE BY NEUTRON ACTIVATION ANALYSIS. Haller, William A. (Washington State Univ., Pullman); Filby, Royston; Rancitelli, Louis A.; Cooper, John A. pp 177-83 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

A method was developed for the simultaneous determination of 15 elements (Co, Cs, Cr, Se, Hg, As, Fe, Rb, Zn, Mn, Na, K, Cu, Br, and P) in plant tissue by neutron activation of freeze-dried samples and γ detection with a solid state Ge(Li) detector. For replicate samples the average deviation about the mean was <10% for Se, Fe, Mn, Zn, and Cu and <25% for the other elements. (B.L.M.)

124 SIMULTANEOUS DETERMINATION OF ARSENIC, ANTIMONY, AND MERCURY IN BIOLOGICAL MATERIALS BY NEUTRON ACTIVATION ANALYSIS. Hadzistelios, I.; Grimanis, A. P. (Democritos Nuclear Research Center, Athens). pp 184-9 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Biological materials, such as blood and kale, were sealed in quartz tubes and irradiated with neutrons. Chemical separations by both solvent extraction and ion exchange after the addition of inert carriers were necessary before the γ radiation of As, Sb, and Hg was determined with a scintillation crystal. The sensitivities found were 0.005 μg for As, 0.010 μg for Sb, and 0.020 μg for Hg. (B.L.M.)

125 INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS OF TOBACCO PRODUCTS. Nadkarni, R. A.; Ehmann, W. D. (Univ. of Kentucky, Lexington). pp 190-6 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Tobacco products were analyzed for 11 elements (La, Br, As, Cr, Se, Ag, Zr, Sc, Sb, Zn, Co) by neutron activation using a high resolution Ge(Li) detector. The products analyzed consisted of burley tobacco leaves, stalks, ashes, 19 different brands of cigarette tobacco, and 2 brands each of pipe and cigar tobacco, as well as cigarette papers used with 12 different brands. The results for determination of the individual elements in each product are tabulated. (B.L.M.)

126 SIMULTANEOUS DETERMINATION OF ARSENIC AND COPPER IN WINES AND BIOLOGICAL MATERIALS BY

NEUTRON ACTIVATION ANALYSIS. Grimanis, Apostolos P. (Democritos Nuclear Research Center, Athens). pp 197-202 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

A simultaneous determination is reported for Cu and As in wines, bone, blood, and kale by neutron activation, chemical separation, and γ spectrometry. The overall standard deviation of the method was ±5.3% for Cu and ±5.7% for As. Selenium interferes with the As determination when present in amounts >10 μg. (B.L.M.)

127 ASPECTS OF LOW TEMPERATURE IRRADIATION IN NEUTRON ACTIVATION ANALYSIS. Brune, Dag (Aktiebolaget Atomenergi, Nykoping, Sweden). pp 203-6 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Apparatus and method are described for low-temperature activation analysis of aqueous solutions for iodine and of biological tissue and water for Hg in which the mutual flux perturbation effect can be eliminated. A device is described for the simultaneous irradiation of 60 solid frozen 0.5-ml samples for I analysis. The γ spectra of the ^{128}I were measured directly in the solution without chemical separation. Iodine in the concentration range of 25 μg to 25 mg was analyzed with a standard deviation of <5%. Rainwater samples and fish tissue were frozen and analyzed for Hg; however, an isotopic separation process was necessary for the Hg determination. (B.L.M.)

128 DETERMINATION OF THE SPECIFIC ACTIVITY OF COMMERCIAL ^{125}I PREPARATIONS BY NEUTRON ACTIVATION ANALYSIS. Heydorn, K. (Research Establishment Riso, Roskilde, Denmark). pp 207-15 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Samples of carrier-free ^{125}I for protein iodination were analyzed for total iodine by neutron activation. Samples were counted for the initial determination of ^{126}I and kept at -20°C until the ^{125}I:^{126}I ratio was $>10^4$. The activity was then counted for 80 min; the samples purged with CO_2 and then recounted. After irradiation in a thermal neutron flux of 7×10^{12} ncm^{-2} sec^{-1}, the samples were counted and a difference spectrum was recorded for evaluation of the 441-keV photopeak to be compared with a standard. After 12 days, the sample was again counted and the 386-keV photopeak from ^{126}I was corrected for ^{126}I present before irradiation. The loss of activity by CO_2 purging was also considered. Concentrations of ^{125}I from 6.5 to 15.7 mCi/μg corresponding to 37.5 to 90% of a truly carrier-free product were obtained for the 7 commercial samples. (B.L.M.)

129 INVESTIGATIONS ON THE AGE AND PLACE OF ORIGIN OF PAINTINGS BY NEUTRON ACTIVATION ANALYSIS. Lux, F.; Braunstein, L.; Strauss, R. (Technische Hochschule, Munich). pp 216-25 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

A method is reported for the determination of Cr, Mn, Cu, Ag, Sn, Sb, Ba, Au, and Hg in white lead by neutron activation, radiochemical separation, and γ spectrometry. Two separation schemes are given: one for short-time irradiated samples for determination of Mn, Cu, Ba, and Au; and one for long-time irradiated samples for determination of Cr, Ag, Sn, Sb, and Hg. Lead in the samples was determined by anodic stripping. A series of analyses were carried out on paintings from various periods in history. From results of the analyses, the region of origin of the painting could be determined, but no definite dating was possible. The distribution of trace elements is a valuable tool in the discrimination of new white lead from old white lead to uncover forgeries. (B.L.M.)

130 AN INVESTIGATION OF THE SILVER CONTENT OF ROMAN COINAGE BY NEUTRON ACTIVATION ANALYSIS. Gibbons, D.; Lawson, D. (Atomic Energy Research Establishment, Wantage, Eng.). pp 226-9 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Neutron activation and γ spectrometry were used for the determination of Ag in some 700 coins. Most of the coins traced the dilution of pure Ag Roman coinage, but some sixpence dated 1872-3 from the reign of Queen Victoria and dated 1921-5 from the reign of King George V were analyzed by the same procedure. Computer treatment of the data was used. The Ag content of the coins varied from 3 to 70%. (B.L.M.)

131 NONDESTRUCTIVE ACTIVATION ANALYSIS OF ANCIENT COINS USING CHARGED PARTICLES AND FAST NEUTRONS. Meijers, P. (Instituut voor Kernphysisch Onderzoek, Amsterdam). pp 230-45 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

A nondestructive method is described for the determination of Cu and Ag in Au coins, Cu, Au, and Pb in Ag coins, and Fe, Ni, As, Sn, Sb, and Pb in Cu coins. Gold and Ag coins were irradiated with 30-MeV protons and 26-MeV deuterons, respectively, and Cu coins were irradiated with fast neutrons. The lower detection limits for Cu and Ag in Au coins were 0.005 and 0.05%, respectively. For Cu, Au, and Pb in Ag coins the lower detection limits are 0.01, 0.1, and 0.1%, respectively. The results for various impurities in coins are tabulated. (B.L.M.)

132 THE ANALYSIS OF ENGLISH AND AMERICAN POTTERY OF THE AMERICAN COLONIAL PERIOD. Olin, Jacqueline S.; Sayre, Edward V. (Brookhaven National Lab., Upton, N. Y.). pp 246-50 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

A study was carried out to determine whether pottery manufactured in North Devon, England during the 17th century showed a compositional uniformity, and whether or not potsherds from American sites can be distinguished from or identified with North Devon pottery. A method of nondestructive neutron activation and measurement of γ spectra using a Ge(Li) detector was used to determine La, Sc, Eu, Fe, Co, Ce, Th, and Cr in the potsherds. A uniform composition was found for the North Devon pottery; and with few exceptions, the composition of the specimen from American sites agreed with those from North Devon. (B.L.M.)

133 COMPARISON OF FORENSIC SOIL SPECIMENS BY NEUTRON ACTIVATION ANALYSIS. Hoffman, C. M.; Brunelle, R. L.; Snow, K. B.; Pro, M. J. (Internal Revenue Service, Washington, D. C.). pp 251-5 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Soil samples from Georgia, Tennessee, and Washington were analyzed for Cl, Mn, Na, Sc, Ba, La, and Sm by neutron activation and γ spectrometry. The samples were collected over a 400-yd-dia collection grid, and some elements varied whereas others were more uniform. This method provides data for comparing soil samples from two or more different regions. (B.L.M.)

134 RECENT FORENSIC APPLICATIONS OF INSTRUMENTAL ACTIVATION ANALYSIS. Perkons, Auseklis K. (Centre of Forensic Sciences, Toronto); Jervis, Robert E. pp 256-64 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

High resolution Ge(Li) detectors for measurement of γ radiation after neutron activation brought about the following recent advances in forensic research: (1) analysis of individual human hair specimens for Na, Sc, Cr, Mn, Co, and Cu; (2) determination of death due to electrocution as evidenced by deposits of Cu and Na on victims' skin; (3) identification of bone fractures caused by Pb bullets; and (4) origin of narcotic samples. (B.L.M.)

135 THE EXAMINATION OF ACTUAL CASE EVIDENCE SAMPLES BY NEUTRON ACTIVATION ANALYSIS. Schlesinger, H. L.; Lukens, H. R.; Settle, D. M. (Gulf General Atomic, Inc., San Diego, Calif.). pp 265-71 of Modern Trends in Activation

Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Neutron activation analysis has been applied to criminal cases and the following examples are discussed: (1) detection of gunshot residues by the presence of Ba and Sb; (2) characterization of human hair; (3) determination of Sb, As, Al, and Ag in bullet lead for bullet characterization; (4) discrimination between paint pigments; and (5) determination of Hg in oats alleged to have poisoned animals. The data for various cases are tabulated. (B.L.M.)

136 ARSENIC CONTENT OF HUMAN HAIR AFTER WASHING AS DETERMINED BY ACTIVATION ANALYSIS. van den Berg, A. J.; de Goeij, J. J. M.; Houtman, J. P. W.; Zegers, C. (Reactor Instituut, Delft, Netherlands). pp 272-82 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Various samples of human hair were analyzed for As by neutron activation and radiochemical separation. The effects of various washing procedures on the As content of the hair are tabulated. The As impregnated in the hair by As(V) solutions of various strengths and at various pH's was at least 93% removed by certain washings. However, when As was distributed through the hairs by oral dosing of the person with As, only between 10 and 40% of the As could be desorbed. Washing of the hair from people working in the As industry resulted in only ~50% desorption. (B.L.M.)

137 COMPARISON OF ACTIVATION ANALYSIS AND SPARK SOURCE MASS SPECTROMETRY FOR FORENSIC APPLICATIONS. Williamson, T. G.; Harrison, W. W. (Univ. of Virginia, Charlottesville). pp 283-87 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Neutron activation analysis and spark source mass spectrometry were compared with respect to characterization of samples, precision and reproducibility of data, amount of sample required, sample handling, and time for analysis. The two methods were compared on samples of human hair that were analyzed for Al, Br, Cl, Mn, S, Ca, Na, Cu, Au, Mg, Zn, Si, P, Cr, Ti, Ni, Co, As, Sr, Mo, Sn, I, Ba, W, and Pb. (B.L.M.)

138 ROUTINE DETERMINATIONS OF Al, K, Cr, AND Sn IN GEOCHEMISTRY BY NEUTRON ACTIVATION ANALYSIS. Das, H. A.; van Raaphorst, J. G.; Umans, H. J. L. M. (Reactor Centrum Nederland, Petten, Netherlands). pp 291-301 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Procedures for the determination of Al and K in geochemical samples are discussed in detail. For Al determination mathematical calculations are necessary to correct for dead time. Potassium is determined by scintillation counting of the γ rays of ^{42}K. Chromium is determined by γ counting of ^{51}Cr after neutron activation, but chemical separation is necessary to eliminate the interference of the ^{233}Th daughter, ^{233}Pa. The determination of Sn is based upon the reaction: $^{112}Sn(n,\gamma)^{113}Sn(T_{\frac{1}{2}} = 119\ days) \beta^- \rightarrow {}^{113}In(T_{\frac{1}{2}} = 102\ min)$. The ^{113}In is isolated and counted using its 0.392-MeV γ ray. Data for the determination of Sn in some standard rocks are tabulated. (B.L.M.)

139 DETERMINATION OF TRACE ELEMENTS IN METEORITES BY NEUTRON ACTIVATION ANALYSIS. Kiesl, Wolfgang (Univ., Vienna). pp 302-7 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Meteorite samples were irradiated, cooled for 1 day, and a H_2S distillation performed. Selenium, As, Sb, Sn, Hg, and Re, which were found in the distillate, were separated by ion exchange and precipitation of Se by SO_2. Ruthenium and Os were distilled from a boiling aqueous solution by adding $KBrO_3$ and assayed by γ spectrometry. After distillation of Ru and Os, the silicate residue was removed, and Fe, Au, and Mo extracted with diethyl ether from 7N HCl and separated by anion exchange. The aqueous phase from ether extraction was poured through an anion exchange column to retain Ir, Co, Zn, and In. With choice of proper activity of eluant, Co, In, and Zn were eluted; and Ir retained. Scandium and Cr were separated from the 7N HCl effluent by precipitation in order that Rb and Cs could be determined. Results obtained by the neutron activation method on several chrondites are tabulated. (B.L.M.)

140 DETERMINATION OF SOME RARE EARTHS IN ROCKS AND MINERALS BY NEUTRON ACTIVATION AND GAMMA-GAMMA COINCIDENCE SPECTROMETRY. Michelsen, O. B.; Steinnes, E. (Institutt for Atomenergi, Kjeller, Norway). pp 315-19 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Methods are described for the determination of Eu in some rocks and minerals by measurement of the 9.3-hr ^{152m}Eu or 12-yr ^{152}Eu by γ-γ coincidence spectrometry. Five days after irradiation La was determined through the 490--1590-keV coincidence of ^{140}La, and Sm was determined by gating with the 41-keV x ray of ^{153}Sm and measuring the 103-keV γ ray. Terbium was determined 2 wk after irradiation by gating over the 880-keV to 970-keV photopeaks and measuring the 298-keV peak. The determination of Yb and Lu was found to be difficult owing to mutual interference. Results on 4 different test samples are tabulated. (B.L.M.)

141 NEUTRON ACTIVATION METHOD FOR THE ISOTOPIC ANALYSIS OF LEAD. Parekh, P. P.; Sankar Das, M.; Athavale, V. T. (Bhabha Atomic Research Centre, Trombay, India). pp 320-6 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Studies were carried out to evaluate the attainable precision in the determination of the $^{208}Pb:{}^{204}Pb$ ratio with a view to measuring the age of galenas. After neutron irradiation, radiochemical separation was carried out and β activity was measured with a gas flow β proportional counter and γ activity was measured with a γ spectrometer. The overall precision of the method was evaluated and the results are presented. The model-age determinations for a few galenas are tabulated. (B.L.M.)

142 DETERMINATION OF PROTACTINIUM BY NEUTRON ACTIVATION AND ALPHA SPECTROMETRY. Rosholt, J. N.; Szabo, B. J. (Geological Survey, Denver). pp 327-33 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

The ratio of $^{231}Pa/^{235}U$ for several rocks was determined by neutron activation and α spectrometry. An ion exchange separation was necessary to remove ^{235}Pa and ^{210}Po from U after irradiation. The results of several irradiations and measurements on a granite reference sample containing 24 ppM U and 83 ppM Th with ^{231}Pa in radioactive equilibrium with ^{235}U are tabulated. The $^{231}Pa/^{235}U$ activity ratio and in some cases $^{230}Th/^{234}U$ and $^{234}U/^{238}U$ are tabulated for several volcanic rocks. (B.L.M.)

143 USE OF A Ge(Li) DETECTOR AFTER SIMPLE CHEMICAL GROUP SEPARATION IN THE ACTIVATION ANALYSIS OF ROCK SAMPLES. IV. SIMULTANEOUS DETERMINATION OF STRONTIUM AND BARIUM. Higuchi, H. (Rikkyo Univ., Yokosuka, Japan); Tomura, K.; Takahashi, H.; Onuma, N.; Hamaguchi, H. pp 334-8 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

A method is reported for the determination of Sr and Ba in rocks by neutron activation and γ spectrometry using a Ge(Li) detector after a rapid chemical separation by precipitation as the carbonates. Strontium and Ba concentrations were measured in 6 standard rock samples, and the results are summarized. The lower detection limits of the method are 10 ppM of Sr and 5 ppM of Ba. (B.L.M.)

144 ACTIVATION ANALYSIS OF GEOCHEMICAL MATERIALS USING Ge(Li) DETECTORS. Filby, Royston H.; Haller, William A. (Washington State Univ., Pullman). pp 339-46 of

Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.
From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

A neutron activation method consisting of 3 different procedures for different groups of elements is described for determination of trace elements in rocks and meteorites. Short neutron irradiation of samples and standards followed by rapid transfer to the counting system allows the determination of Al, Mn, Na, V, Ti, Ca, and in some cases Mg. Long irradiation followed by a 1-month decay period allows the determination of Sb, Co, Zn, Sc, Cr, Eu, Th, U, Ba, Ta, Hf, and Fe. In most irradiated silicate rocks and meteorites, the high ^{24}Na activity masks several (n,γ) activation products, but dissolution of the sample and removal of the sodium by ion exchange allow the determination of K, Ga, Zn, La, Cu, Sr, Ba, Mn, and Eu. Results for major and trace elements in 7 standard rock samples are tabulated. (B.L.M.)

145 Ge(Li) DETECTORS IN THE ACTIVATION ANALYSIS OF GEOLOGICAL SAMPLES. Randle, Keith; Goles, Gordon G. (Univ. of Oregon, Eugene). pp 347-52 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.
From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

A method is described for the determination of trace elements in silicic and basic rocks using a high resolution 30 cm^3 coaxial Ge(Li) detector with computer analysis of the recorded spectra. Typical spectra were recorded and a high density of lines up to ~150 keV indicated. More detailed observation of this region was possible using a 1 cm^2 + 0.6 cm Ge(Li) detector having a thin dead-layer on the front surface. The window of the detector consisted of a thin Be foil, and the system has a very low counting efficiency but very good resolution. The method was applied to distinguishing between ash falls from several volcanic sites in Oregon. (B.L.M.)

146 AN INVESTIGATION OF TRACE ELEMENTS IN MARINE AND LACUSTRINE DEPOSITS BY MEANS OF A NEUTRON ACTIVATION METHOD. Landstrom, O. (Aktiebolaget Atomenergi, Stockholm); Samsahl, K.; Wenner, C. G. pp 353-66 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.
From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

A neutron activation method for trace elements in marine and lacustrine deposits was applied to samples from the Visken Valley on the Swedish West Coast to study shore fluctuations. After an initial short-time irradiation of the samples, Mn was determined; and then the samples were re-irradiated for 3 days. After a 1- or 2-day decay period, the trace elements were separated into about 20 groups by a chemical separation method, which is shown schematically. The results of the determination of 30 elements (Sb, As, Br, Ca, Ce, Cs, Cr, Co, Eu, Ga, Hf, Fe, La, Lu, Mn, Hg, Rb, Sm, Sc, Se, Na, Sr, Ta, Tb, Th, W, U, Yb, Zn, and Zr) are tabulated for various samples taken at different depths. The results of activation analysis are discussed with respect to geologic development and to the properties of the various strata. (B.L.M.)

147 GEOCHEMICAL SURVEYING BY MEANS OF NEUTRON ACTIVATION ANALYSIS WITH POSSIBLE APPLICATION TO CONTINENTAL DRIFT STUDIES. Uken, Ernst A.; Santos, Gabriel G.; Wainerdi, Richard E. (Texas A and M Univ., College Station). pp 367-78 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.
From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

A method of neutron activation analysis using a Ge(Li) detector was applied to mapping the Enchanted Rock Batholith near Llano, Texas. The samples were observed over a counting period of 60 min and a decay period of 40 days, and quantitative values for Fe, Sc, Co, La, Eu, Hf, and Ta are tabulated. The symmetry of the elemental trends are in agreement with generally accepted and mapped nearly concentric zonal arrangement of the various rock types. Some conclusions drawn from this study were applied to continental drift studies. (B.L.M.)

148 VOLCANOLOGICAL STUDIES USING ACTIVATION ANALYSIS TECHNIQUES. Santos, Gabriel; Wainerdi, Richard E. (Texas A and M Univ., College Station). pp 379-87 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.
From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Volcanic ash, volcanic bomb, olivine-bearing basaltic rock, and water samples collected from the Taal volcano area in the Philippines were analyzed by neutron activation and γ spectrometry for Si, O, Mg, Fe, Al, Cu, Na, Mn, and Sc. Typical γ spectra for the samples are shown. Copper, Fe, Na, and Mn were present in all samples. The data seem to indicate that the recent Taal eruption was not essentially a phreatic eruption but that heated groundwater or lake water was probably mixed with magmatic material. (B.L.M.)

149 ALUMINUM AND SILICON ABUNDANCES OF SOME ITALIAN METEORITES AS DETERMINED BY INSTRUMENTAL ACTIVATION ANALYSIS. Meloni, Sandro; Maxia, Vera; Buzzi, Silvano (Univ., Pavia, Italy). pp 388-94 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.
From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Silicon and Al were determined in 8 Italian meteorites and a standard rock sample by irradiation with 14-MeV and thermal neutrons, respectively. Activity measurements were made with a γ spectrometer using a NaI(Tl) detector. The Al content was determined directly by comparing the net photopeak of the sample with a standard, and the Si content was evaluated by correcting for the contribution of Al from the meteorite. The values for the individual rocks are tabulated, and the average values for each different type of chondrites are summarized. (B.L.M.)

150 NEUTRON ACTIVATION ANALYSIS OF INDIVIDUAL COSMIC SPHERULES. Millard, H. T. Jr. (Geological Survey, Denver). pp 395-8 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.
From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Cosmic spherules 150- to 350-μ-dia were separated from $1\frac{1}{2}$ tons of Pacific Ocean sediment and analyzed for Ni, Co, Mn, and Ir by neutron activation and γ spectrometry. For measurement of short-lived nuclides, the spherules were mounted on mica sheets for irradiation in order to record fission tracks from U; but for determination of long-lived nuclides, the samples were wrapped in Al foil and irradiated in a reactor. On the basis of analysis, the spherules can be divided into 2 groups: (1) low Mn, high Ir, and high specific gravity and (2) high Mn, probably low Ir, and low specific gravity. The spherules in the first group probably come from iron meteorites while those in the second group are probably terrestrial. (B.L.M.)

151 NEUTRON TECHNIQUES FOR IN SITU ELEMENTAL ANALYSIS. Mandler, John W.; Reed, John H. (Illinois Inst. of Tech., Chicago). pp 404-8 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.
From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

The composite capture, inelastic, and activation γ spectra from large samples of basalt and granite were obtained using a Pu–Be neutron source and a 14-MeV pulsed neutron generator with NaI(Tl) and Ge(Li) detectors. The spectra with different combinations of detector and source are recorded and indicate that when a Ge(Li) detector is used with a pulsed neutron generator a better analysis of data and greater precision of results are obtained. The pulsed generator is needed for timing proposed if a NaI(Tl) detector is used. (B.L.M.)

152 SIMULTANEOUS MEASUREMENT OF SEVENTEEN TRACE ELEMENTS IN EIGHT GEOCHEMICAL STANDARDS: A NOVEL ADAPTATION OF NEUTRON ACTIVATION ANALYSIS. Case, D. R.; Laul, J. C.; Wechter, M. A.; Schmidt-Bleek, F.; Lipschutz, M. E. (Purdue Univ., Lafayette, Ind.). pp 409-19 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.
From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

A method for the determination of As, Sb, Bi, Tl, Hg, Ga, Ge, Os, Re, Te, Se, Sc, Co, Mo, Au, Cs, and Zn in stony meteorites utilizes neutron activation, high-resolution γ detectors, a re-irradiation technique for chemical yield determination, and computer analysis of the data. A chemical separation divides the elements into 3 major groups, one for β counting and 2 for γ counting. Eight geochem-

ical standards were analyzed, and the results compare well with those obtained by other methods. (B.L.M.)

153 ON THE FEASIBILITY OF THE DETERMINATION OF WATER, SALT, AND SULPHUR IN CRUDE OIL BY MEANS OF NEUTRON ACTIVATION ANALYSIS. Gorski, L.; Janczyszyn, J.; Loska, L. (Inst. of Nuclear Techniques, Krakow). pp 420-9 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

An apparatus and method are described for constant monitoring of crude oil in a pipeline for H_2O, salt (as Na), and S by neutron activation. The optimum experimental conditions, such as flow rate and irradiation time, are reported. The results seem to be good in the case of $O(H_2O)$ and Na, but the results obtained for S seem to be rather uncertain. (B.L.M.)

154 INVESTIGATION OF MATERIAL TRANSFER BY NEUTRON ACTIVATION ANALYSIS. Gibbons, D.; Lawson, D.; Metcalfe, B.; Simpson, H. (Atomic Energy Research Establishment, Wantage, Eng.). pp 430-6 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Activation analysis was applied to investigation of material transfer by both analysis of an element already in the system or of an inactive tracer added to the system. Cerium naphthenate was added to lithographic ink, and the La impurity in the Ce (5% relative to Ce) was activated for monitoring the ink thickness. Activation analysis of lubricating oils from certain machines can be used to indicate bearing wear. Since all trace elements suitable for wear detection in coal-grinding machinery were found to be present in even the purest coal at concentrations, which ruled out the use of these elements as tracers, the scheme was not suitable for wear measurements in this industry. (B.L.M.)

155 APPLICATIONS OF ACTIVATION ANALYSIS TO DETERMINATION OF CEMENT IN CONCRETE. Iddings, F. A.; Arman, Ara (Louisiana State Univ., Baton Rouge). pp 437-43 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Cement compositions were determined by neutron activation and γ spectrometry and determination of ^{49}Ca from Ca activation and ^{28}Al from Si activation. Activation time of 1 sec followed by a 720-sec decay period and a 400 sec counting period with a Ge(Li) detector gave the best results. A unit for field operation was devised from a specially mounted Kaman Nuclear Corp. Model A-700 accelerator, a gasoline-powered 110-V ac generator, a multichannel analyzer, and a printer, all of which fitted into the back of an air-conditioned station wagon. The equipment operated satisfactorily under field conditions, but whether or not the necessary precision can be obtained was not established. (B.L.M.)

156 DETERMINATION OF SODIUM AND POTASSIUM IN SOLID PROPELLANTS. Barber, W. H. (Naval Ordnance Station, Indian Head, Md.); Dengel, O. H.; Vogt, R. H.; Strain, C. V. pp 444-9 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Solid propellants were analyzed for Na and K by thermal neutron activation at two different neutron fluxes to yield ^{24}Na and ^{42}K. If Al and Mg are present in the samples, their reactions on irradiation can interfere with the primary reaction for Na. For solid propellants studied, no Mg could be detected, but it was necessary to use a specially designed thermal column that effectively suppressed the reaction of $^{27}Al(n,\alpha)^{24}Na$ to eliminate the Al interference. Using the thermal column, Na determinations at the 1- to 10-ppM level were achieved for aluminized (10 to 20% Al) propellants. Both Sc and Ca interfere with the activation of K, but since no Sc and only traces of Ca were found in the propellants, no interference was noted. Eight batches of Sidewinder-1-C solid propellant was analyzed; and the results, normalized for decay, weight, and duration of irradiation, are tabulated. (B.L.M.)

157 THE APPLICATION OF ISOTOPIC NEUTRON SOURCES TO CHEMICAL ANALYSIS FOR PROCESS CONTROL IN THE METALLURGICAL INDUSTRY. Kuusi, J. (Technical Univ. of Helsinki, Otaniemi, Finland). pp 450-6 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Chromium, Al, and Si were determined in some metallurgy samples for process control by neutron activation using a ^{241}Am/Be source and γ spectrometry. Phosphorus, Al, Fe, and Mn present in the samples can interfere with the Si determination. Vanadium interferes with the determination of Cr. Irradiations and counting geometries are shown along with typical spectra from irradiated chrome concentrate and pyrite smelter slag. (B.L.M.)

158 ROUTINE DETERMINATION OF MAJOR COMPONENTS BY ACTIVATION ANALYSIS. Cosgrove, James F. (General Telephone and Electronics Labs., Inc., Bayside, N. Y.). pp 457-9 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Activator using a 14-MeV, 3-MeV, or thermal neutron generator and γ spectrometer was applied to the determination of major components of thin film semiconductor devices of SiO_2, Al_2O_3, and mixed oxide films prepared by chemical vapor deposition. Activation analysis was used to determine the oxygen to metal ratio in monoxides of V and Ti. Analysis of activator and coactivator concentrations of phosphors, and composition of alloys, glasses, and frits was also carried out. (B.L.M.)

159 INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS USING REACTOR, Ge(Li) DETECTOR, AND COMPUTER. Anders, Oswald U. (Dow Chemical Co., Midland, Mich.). pp 460-5 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

A method of instrumental neutron activation analysis for qualitative as well as quantitative analysis of up to 10 elements simultaneously and with a single irradiation is described. A Ge(Li) detector is used in conjunction with computer analysis of the data. The times of activation, flux to which the samples were exposed, weight and volume of sample, and beginnings and ends of the counting interval and an arbitrary number of spectra of the sample constitute the input data to the computer, and the computer program, written in ALGOL language, first identifies the photopeaks of the spectrum, measures their energy equivalent and area, corrects the peak areas for Compton bremsstrahlung and background base of the peak, and normalizes to counts/sec and 1×10^{11} n $\cdot$ $cm^{-2} \cdot sec^{-1}$. (B.L.M.)

160 SUBSTOICHIOMETRIC DETERMINATION OF MOLYBDENUM AND PALLADIUM BY NEUTRON ACTIVATION ANALYSIS. Doctor, Z. K.; Nadkarni, R. A.; Haldar, B. C. (Inst. of Science, Bombay). pp 468-72 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Substoichiometric amounts of Mo are determined in steel and of Pd in other alloys by neutron activation followed by chemical separation of Mo and Pd from most other constituents by extraction of Mo and Pd complexes. Molybdenum is extracted into $CHCl_3$ as the α-benzoinoximate complex and Pd into benzene as the isonitrosoacetophenone complex. After separation of the Mo complex, the organic phase is evaporated to dryness and the residue is counted on an end window G-M counter through an Al absorber to eliminate counting of the conversion electrons of ^{99m}Tc. The sample was also counted on a γ-ray spectrometer. The extraction of Pd complexes were counted on a γ spectrometer with 5 V windows. The organic extract was also evaporated to dryness and counted on a G-M counter. The method has been applied to an artificial mixture containing Fe, Cr, Ni, Co, Mn, and traces of P, S, and Mo, and to a standard steel alloy, 60B. The accuracy and precision of the method are 3.5 and 1.2%, respectively. The method for Pd was tested on a synthetic mixture containing 2.0 μg of Pd and 20 to 200 μg each of Ru, Rh, Os, Ir, Pt, Ag, and Au and on a Ag alloy. The accuracy and precision of the method are 4 and 3.7%, respectively. (B.L.M.)

161 ACTIVATION ANALYSIS BY STANDARD ADDITION AND SOLVENT EXTRACTION. DETERMINATION OF CERTAIN TRACE ELEMENTS IN ANTIMONY. Alian, A. (Atomic Energy Establishment, Cairo). pp 473-4 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

The method of activation analysis by standard addition and solvent extraction is suitable for the determination of elements such as U and Th, which on irradiation give rise to nuclides that have no stable isotopic carriers. The method was applied to the determination of traces of Sc, Co, Th, Zn, Ag, and Hg in Sb. The induced Sb isotopes are separated by extraction with isopropyl ether while the isotopes of the elements to be determined are fractionated by extraction with tridodecylamine, thenoyltrifluoroacetone, and TBP. (B.L.M.)

162 NONDESTRUCTIVE DETERMINATION OF ELEMENTS IN SPECIFIC FRESHWATER MICROPLANKTON BY ACTIVATION ANALYSIS. Merlini, Margaret; Ravera, Oscar; Bigliocca, Carla (EURATOM, Ispra, Italy). pp 475-81 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

A method is described for obtaining relatively pure samples of freshwater microplankton and the activation techniques for the determination of Ca, Na, K, and Mn in zooplankton and phytoplankton from Lago Maggiore in Italy are described. A comparison is made of the Ca content of 2 groups of zooplankton from 4 lakes: Lago Maggiore, Lago di Varese, Lago di Comabbio, and Lago di Monate. (B.L.M.)

163 ISOTOPIC ANALYSIS OF URANIUM BY NEUTRON ACTIVATION AND HIGH RESOLUTION GAMMA-RAY SPECTROMETRY. Mantel, M.; Gilat, J.; Amiel, S. (Soreq Nuclear Research Centre, Yavne, Israel). pp 482-9 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

The ratios of $^{238}U/^{235}U$ and 7 different fission products were determined in U samples by neutron activation and γ spectrometry using high-resolution Ge(Li) detectors. The fission products determined were ^{99}Mo, ^{135}Xe, ^{91}Y, ^{133}I, ^{132}I, ^{143}Ce, and ^{97}Nb. The method was applied to 8 U_3O_8 samples of known isotopic composition, and the results are tabulated. The method is applicable only to low and intermediate ^{235}U concentrations, because above ~10% the ^{239}Np peaks are almost completely masked by the fission products. (B.L.M.)

164 PULSED NEUTRON ACTIVATION ANALYSIS SYSTEM FOR SHORT-LIVED RADIOISOTOPES. Naughton, W. F.; Jester, W. A. (Pennsylvania State Univ., University Park). pp 490-4 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

A program is described for design and modification of the existing Pennsylvania State TRIGA Reactor (PSTR) to make it capable of handling and analyzing short-lived radioisotopes with half-lives as low as 1 to 2 sec. The major designs and modifications incorporated into the PSTR pneumatic system and rabbits are illustrated and includes an inshield terminus assembly that permits immediate passage of the irradiated sample and its container to the detector position. Both bare and Cd terminus were evaluated for performance for thermal activation and fast neutron activation, respectively. Since the sample vials contained ~100 μg of Al, the short-lived activation analysis with bare terminus was limited to those isotopes with photopeaks above that of ^{28}Al or those that produced stronger γ spectra than the ^{28}Al of the vials. The detection limits obtained through activation by the pulsed method are tabulated for O, F, Na, S, and P. (B.L.M.)

165 THE DETECTION AND DETERMINATION OF FISSONABLE SPECIES BY NEUTRON ACTIVATION: DELAYED NEUTRON COUNTING. Brownlee, James L. Jr. (Univ. of California, Livermore). pp 495-500 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Fissionable species, ^{233}U, ^{235}U, and ^{239}Pu, can be determined by activation and measurement of delayed neutrons in the tens-of-nanograms region. Higher detection limits are possible for the fast-fissioning species. A single irradiation in a Cd-shielded container and detection of the neutrons by an array of BF_3 proportional counters were used. Half-lives and yields for the thermal fissioning species, ^{235}U and ^{239}Pu, and for the fast fissioning species, ^{235}U, ^{239}Pu, ^{238}U, ^{240}Pu, ^{233}U, and ^{232}Th, are tabulated (B.L.M.)

166 A HIGH-INTENSITY ^{241}Am-Be-^{242}Cm NEUTRON SOURCE. Wahlgren, M.; Wing, J.; Stewart, D. C. (Argonne National Lab., Ill.). pp 501-6 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Eight high-intensity isotopic neutron source slugs were prepared by irradiation of ^{241}Am-Be capsules to produce ^{242}Cm. Each capsule emitted ~1.2×10^9 n/sec and produced a spectrum of unmoderated neutrons primarily in the range from 4 to 8 MeV. The capsule and source holder are described and features of the irradiation assembly are discussed. The detection sensitivities of ~60 elements were determined using this new source assembly. (B.L.M.)

167 NEW FACILITIES FOR ACTIVATION ANALYSIS AT THE GRENOBLE CENTER FOR NUCLEAR STUDIES. Laverlochere, J. (CEN, Grenoble, France). pp 507-11 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Irradiation facilities consisting of 2 swimming pool reactors, a neutron accelerator, and a variable energy cyclotron at Grenoble, France, are described. The new hot cell facilities and apparatus for automatic ion exchange resin separations are described. Counting and computation facilities and new laboratories are discussed briefly. (B.L.M.)

168 THE NUCLEAR ANALYSIS PROGRAM OF THE NRL CYCLOTRON FACILITY. Eisele, John A.; Larson, Reginald E. (Naval Research Lab., Washington, D. C.). pp 512-16 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washigton, D. C., National Bueau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

The 76-inch sector-focused cyclotron operated by NRL and the accompanying laboratory and counting facilities are described. The system is being studied for use in trace element determination in oceanographic studies. Presently, reaction cross section data of elements useful in activation analysis, such as Ca, Mg, Si, and Sr, are being gathered. Some studies on importance of uniform density and thickness of samples are discussed. (B.L.M.)

169 THE LOCALIZATION OF IMPURITIES IN ACTIVATION ANALYSIS DEMONSTRATED BY ANALYSES OF SEMICONDUCTOR SILICON. Martin, J. (Siemens Research Labs., Erlangen, Ger.). pp 517-26 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Activation analysis was combined with autoradiography for analysis of semiconductor Si. Autoradiography can indicate the location of an impurity that is then identified and determined by activation analysis. Combination of the two techniques can provide important indications as to the origin, behavior, or mechanics of impurities. Specific examples of the determination of Hg, S, and Cu in Si are discussed. (B.L.M.)

170 THE DETERMINATION OF COPPER AND GOLD TRACE IMPURITIES IN HIGH PURITY GALLIUM BY ACTIVATION ANALYSIS WITH PRETREATMENT. Nagy, L. G. (Polytechnical Univ., Budapest); Torok, G.; Szokolyi, L.; Giber, J. pp 527-35 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

To provide a method for the determination of Cu and Au in Ga in a medium activity laboratory, a chemical separation by chlorination was necessary to remove most of the Ga from the sample prior to neutron activation. After removal of the bulk Ga, the residue was irradiated and the Cu and Au were separated by ion exchange prior to the determination of individual activity. The geometry and size of the distillation apparatus have a definite influence on the precision and accuracy of the determination. A thorough study of the experimental variables is reported. The error of the Cu determination is ±40% in the range 10^{-6} to 10^{-7} g/g, and the error of Au is ±50% in the range 10^{-8} to 10^{-9} g. (B.L.M.)

171 NEUTRON ACTIVATION ANALYSIS OF LASER CRYSTALS. Ortega, Ruben F. (Imperial Coll. of Science and Tech., London). pp 536-40 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

"Laser crystals" doped with a small amount of a particular ion, e.g., $MgAlO_4 \cdot Cr$, were prepared by growth from solution in PbF_2 by isothermal evaporation between 1200 and 1250°C in partially sealed 100-ml Pt crucibles. Specially prepared MgO and Al_2O_3 were used as starting materials. Conventional analytical methods showed the crystals to contain <10 ppM Pb and provided no other information about impurities. Neutron activation analysis was used to determine rare earths in the doped crystals and crucible impurities. Results were obtained for rare earths, Ir, and Na in the spinel crystals by allowing optimum time for irradiation and decay. The Eu^{2+} was incorporated into the crystals, but the large Nd^{3+} was rejected. The Ir content indicated crucible contamination, but no Pt was detected. (B.L.M.)

172 DETERMINATION OF TRACES OF SELENIUM AND TELLURIUM IN SULPHUR BY NEUTRON ACTIVATION. Arroyo A., A.; Toro G., J. (Instito de Asuntos Nucleares, Bogota). pp 541-3 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Selenium and Te were determined in S by neutron activation and γ spectrometry. The sensitivity for each element was 0.07 μg with a precision of ±1%. (B.L.M.)

173 NONDESTRUCTIVE ACTIVATION ANALYSIS FOR ARSENIC AND ANTIMONY IN SOFT SOLDERING ALLOYS. Rudelli, M. D.; Rocca, H. C.; Baro, G. B. (Comision Nacional de Energia Atomica, Buenos Aires). pp 544-50 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

Optimum neutron irradiation and counting conditions are reported for the determination of As and Sb in Sn and in soft soldering alloys. Because of the complex γ spectra from these materials, it was necessary to use a Ge(Li) detector. Results of typical analyses are tabulated. (B.L.M.)

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Refer also to abstracts 150, 257, 265, 274, 278, 296, 376, 944, 1021, 1025, 1276, 1309, 1823, 2008, and 2009.

174 (ANL-7575, pp 47-76) FLUIDIZATION AND VOLATILITY PROCESSES. Jonke, A. A.; Simmons, J. W. (Argonne National Lab., Ill.).

A 2-in.-dia fluid-bed reactor was used to study the fluorination of uranium and plutonium from simulated thermal light water reactor (LWR) fuels and fast breeder reactor (LMFBR) fuels containing nonradioactive fission product oxides. In these studies, the fuel was first oxidized to $U_3O_8-PuO_2$ fines with oxygen. Uranium was then fluorinated to the volatile hexafluoride with BrF_5 or dilute fluorine, and plutonium was subsequently fluorinated with concentrated fluorine at temperatures of 300 to 550°C. A laboratory-scale study of the absorption of ruthenium fluorides on LiF and other absorbents (NaF, nickel metal, and NiF_2) was performed to evaluate this procedure for the separation of ruthenium from PuF_6. Separation of plutonium fluoride from ruthenium fluoride was demonstrated experimentally. The reaction of fluorine and PuF_6-RuF_5 mixtures with solid LiF at 200 to 500°C resulted in the preferential fixation of ruthenium by the solid phase with decontamination factors of 10^2 to 10^3. The separation was most efficient with LiF at 300 to 400°C and was least efficient at 500°C. The hydrolysis of PuF_6 and the filtration, with fiber filters, of the aerosol formed by the hydrolysis were measured. A total of 2.3 kg of PuF_4 was fluorinated to PuF_6 with elemental fluorine in a fluidized bed of alumina to provide information pertinent to fluoride-volatility process flowsheets. A theoretical study was made to determine the interaction effects, on particle movement and gas flow, of bubbles rising through a fluidized bed in a two-dimensional column and a three-dimensional column. (J.G.B.)

175 (ANL-7575, pp 77-129) MATERIALS CHEMISTRY AND THERMODYNAMICS. (Argonne National Lab., Ill.).

Phase-diagram, thermodynamic, and physical property data have been obtained in order to interpret and evaluate the performance and safety of candidate fast-breeder reactor fuels. A mass spectrometric, Knudsen effusion study of the vaporization of plutonium oxides is in progress. An investigation of the Pu-O phase diagram was initiated. Carbon activities and total pressures are being investigated over the uranium-carbon system where measurements of hydrogen-hydrocarbon concentrations establish the activity of carbon. A resistance-heated calorimetric system was used to determine enthalpies of Na_3Bi at about 850°C. Enthalpies of UB_2 at 579 to 1486°K were determined using an electron-beam-heated calorimetric system. Work is continuing on the program to determine the heat capacity of liquid uranium dioxide. The chemical behavior of irradiated fast reactor fuels and materials is being studied. Microsampling by laser-beam vaporization is being used to sample specimens of stainless steel that have been exposed to sodium. A detailed electron microprobe study was made of a cross section of a UO_2-20 wt % PuO_2 fuel pin irradiated to 2.7 at. % burnup. A program is under way to develop methods of identifying the position in an operating reactor of a subassembly in which fuel failure has occurred. Methods for analyzing the trace element content of EBR-II sodium are being developed. A xenon-tag method of failed fuel identification is being developed for application to EBR-II experimental fuel elements. Standard enthalpies of formation of UB_2 and β-US_2 were determined by fluorine bomb calorimetry. Oxygen bomb calorimetry was used to determine the enthalpies of formation of PuO_2 and PuN. A series of calorimetric combustions of fluorine in excess hydrogen was completed. The reaction of iodine with excess fluorine was studied in a bomb calorimeter. Measurements were made of the enthalpies of dissolution (298°K) in water of crystalline and amorphous boric oxides. The enthalpy of combustion of crystalline boric oxide in flourine was redetermined. Complex formation in Hg-18 at. % Na, In-33 at. % Bi, and Hg-50 at. % In was studied by ultrasonic absorption spectrometry. The thermodynamic activity of sodium in liquid Cs-Na solutions was determined at about 140°C by atomic absorption spectrophotometry. Carbon transport between steels in contact with molten sodium is being studied using carbon-14 tracers. The solubilities of NaCN and N_2 in liquid sodium were measured. A fluidized-bed process was used for preparing UC-PuC powder containing fully enriched uranium. (J.G.B.)

176 (ORNL-4422, pp 304-5) SPECTROPHOTOMETRIC STUDIES OF SOLUTIONS OF LANTHANIDES AND ACTINIDES. (Oak Ridge National Lab., Tenn.).

Spectrophotometric techniques for studying aqueous solutions, especially of the lanthanides, actinides, and transition elements, are being developed and exploited. Studies of non- or low-alpha-active solutions at temperatures less than 100°C are accomplished by regular techniques, while a special spectrophotometer system that is capable of operating at temperatures up to 380°C and pressures up to 10,000 psi has been built to provide containment for alpha-active materials. The latter system was used in a standard laboratory for studying temperature effects (25 to 380°C) on aqueous $Pr(NO_3)_3$, $Nd(NO_3)_3$, and UO_2SO_4, and will be further used to study other lanthanides and low-alpha-active materials before it is moved into a laboratory designed for studying materials that are highly alpha active. In conjunction with the spectrophotometric studies, the densities of aqueous solutions of lanthanides and actinides are being measured over the temperature range 25 to 400°C. (auth)

177 (ORNL-4422, pp 312-15) PREPARATION AND PROPERTIES OF ACTINIDE OXIDES. (Oak Ridge National Lab., Tenn.).

Studies on sols of urania, thoria-urania, and various lanthanide hydroxides were continued. It was found that oxidation of nitrate-stabilized UO_2 sols leads to two colloidal charge-carrying species, as was previously observed for chloride-stabilized systems. In the case of the nitrate-stabilized sol, the more highly oxidized particles have a lower zeta potential, whereas the reverse situation

is found in the chloride-stabilized system. In both systems, CO_2 will reversibly displace the stabilizing ion. Several lanthanide hydroxide sols were used in studies of the effects of aging on the streaming current. All of the sols examined thus far have shown differences in behavior for a day or two after preparation, but appear to reach steady state after 7 to 10 days. Theoretical studies of colloidal systems were continued. (auth)

178 (ORNL-4422, pp 316-21) CHEMISTRY OF CARBIDES, NITRIDES, AND CARBONITRIDES. (Oak Ridge National Lab., Tenn.).

Fundamental studies of the reactions of uranium and thorium carbides, nitrides, and carbonitrides with aqueous solutions were continued. Uranium mononitride dissolved readily in 0.5 to 15.8M HNO_3, yielding a yellow solution containing uranyl, ammonium, and nitrite ions, and an off-gas composed of N_2, NO, N_2O, and NO_2 (with 8 to 16M HNO_3). The quantities of the various nitrogen-containing products were functions of acid concentration, reaction temperature, and time of reaction. The ammonium ion was an intermediate in the oxidation of the nitride nitrogen to free nitrogen. The uranium carbonitride used ($UC_{0.6}N_{0.4}$) in these studies was inert at 80°C in water and in 6M NaOH. The carbonitride reacted with 6M HCl at 25°C and with 6M H_2SO_4 at 80°C, producing primarily CH_4, NH_4^+, H_2, and U^{4+}, and in the case of 6M H_2SO_4, $U(SO_4)_2 \cdot 4H_2O$. In the reactions of the carbonitride with 0.5 to 15.8M HNO_3, nitrous acid, NO, and N_2 were the major products. Twenty to 70% of the carbon was found as CO_2, while the remainder formed nitric acid—soluble organic compound(s). The NH_4^+ and the organic species, as yet unidentified, were intermediate reaction products that slowly oxidized to N_2 and CO_2 respectively. (auth)

179 (ORNL-4437) CHEMISTRY DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING MAY 20, 1969. Moore, G. E. (ed.) (Oak Ridge National Lab., Tenn.). Sept. 1969. Contract W-7405-eng-26. 166p. Dep. CFSTI.

Nine sections are included; an abstract was prepared for each. (P.C.H.)

For abstracts of individual sections see: 180–183, 215, 274, 1822, 1823, and 2082.

180 (ORNL-4437, pp 60-86) CHEMISTRY OF AQUEOUS SYSTEMS. (Oak Ridge National Lab., Tenn.).

Developments are reported for studies on: thermodynamic properties of $HCl-CsCl-BaCl_2$ mixtures; existence of the complex $AgSO_4^-$ in aqueous solutions; a Monte Carlo calculation of some thermodynamic properties of steam using a dipole-quadrupole potential; free energies of electrolyte mixtures; miscibility in the system pyridine—$H_2SO_4-H_2O$; activity coefficients of NaCl at saturation in water mixtures of polyglycols and polyglycol ethers at 50°C; properties of Sephadex quaternary amine anion exchanger; diffusion in aqueous solutions; hyperfiltration with dynamically formed membranes; and thermodynamic studies on the bolaform electrolytes $[Bu_3N-(CH_2)_8-NBu_3]X_2$. (P.C.H.)

181 (ORNL-4437, pp 87-97) ELECTROCHEMICAL KINETICS AND ITS APPLICATION TO CORROSION. (Oak Ridge National Lab., Tenn.).

Developments are reported for studies on: kinetics of the formation and discharge of the superpassive film on Fe; electrochemical behavior of Ti; properties of the suspension electrode; theory of the suspension electrode; Re–Ni suspension electrode catalysts; and kinetics of pit initiation on Ti in chloride solution. (P.C.H.)

182 (ORNL-4437, pp 98-106) NONAQUEOUS SYSTEMS AT HIGH TEMPERATURES. (Oak Ridge National Lab., Tenn.).

Developments are reported for studies on: limits of miscibility in molten salt systems: KBF_4-LiF, Li_2BeF_4-KI, and $Li_2BeF_4-KBF_4$; correlation of solubility of CeF_3 in molten mixtures of Li, Be, and Th fluorides with solvent composition; solubility of Th in molten $LiF-ThF_4$ mixtures; a reference electrode system for possible use in fluoride melts; solubility of La in molten LaI_3; the order-disorder (λ) transition in UO_2; and heat content of $NaBF_4$ and KBF_4 from 298 to 900°K. (P.C.H.)

183 (ORNL-4437, pp 107-43) CHEMICAL PHYSICS. (Oak Ridge National Lab., Tenn.).

Developments are reported for studies on: spectrophotometry of solutions over wide ranges of temperature and pressure; electronic structure of molecules by means of high-resolution electron spectrometry; high-temperature enthalpies of lead halides; heat capacity of potassium pertechnetate from 9 to 310°K; preparation of D_2TcCl_6 for calorimetry; PMR spectra of liquids during photolysis; PMR spectra of ^{17}O-labeled NO_2 in sodium nitrite crystals; neutron diffraction of magnesium chloride hexahydrate; neutron diffraction of calcium chloride hexahydrate and strontium chloride hexahydrate; correcting interatomic distances and angles for thermal motion; higher-order effects in rigid-body motion; diffraction pattern and structure of aqueous ammonium halide solutions; crossed-molecular-beam studies of bimolecular association and unimolecular decomposition reactions; hot atomic halogen beams from sputtering of silver halides; and mass spectra of silane. (P.C.H.)

184 (ORNL-TM-2065(Pt.2)) THE STABILITY OF URANIUM TRIFLUORIDE. PART II. STABILITY IN MOLTEN FLUORIDE SOLUTION. Long, G.; Blankenship, F. F. (Oak Ridge National Lab., Tenn.). Nov. 1969. Contract W-7405-eng-26. 34p. Dep. CFSTI.

The equilibrium quotient, Q^R, for the reaction, $\frac{1}{2}H_{2(g)} + UF_{4(d)} \rightleftharpoons UF_{3(d)} + HF_{(g)}$, was measured in a series of molten mixtures of LiF and BeF_2 containing from 26 to 42.4 mole % BeF_2 and up to 5 mole % UF_4. Over the temperature range from 724 to 950°C the data are represented by the expression $\log_{10} Q^R = \log_{10} (x_{UF_3}/x_{UF_4})(p_{HF}/p_{H_2}^{1/2}) = 4.00 - 9.33\ (10^3/T) + 3.77\ x_{UF_4} + 2.09\ (x_{BeF_2} - 0.30)$. By combining these data with those for the reduction of pure UF_4, values for the activity coefficient of UF_4 and the disproportionation quotient of UF_3 are derived. (auth)

185 (ORO-3234-12) A BIBLIOGRAPHY ON HEAVY ATOM KINETIC ISOTOPE EFFECT RESEARCH, JULY 1959–JUNE 1969. Fry, Arthur; Bennett, G. H.; Everly, C. R.; Meek, W.; Oka, M.; Ookuni, I.; Palmer, B. W.; Pearson, N.; Reppond, K. D.; Wilson, J. C. (Arkansas Univ., Fayetteville. Dept. of Chemistry). Sept. 1, 1969. Contract AT(40-1)-3234. 32p. Dep. CFSTI.

Four hundred thirty-eight references are presented on non-hydrogen kinetic isotope effects, covering the literature from July 1959 through June 1969. Papers are classified by element in alphabetical order and cross references are included. Some general theory and review papers and some papers of related interest are also referenced. (M.C.G.)

186 ISOTOPIC EFFECT UPON THE PHOTOSYNTHESIS OF OZONE. Utirov, B. U.; Panchenkov, G. M.; Korovkin, V. K. (Moscow State Univ.). Zh. Fiz. Khim., 43: 1904-6(July 1969). (In Russian).

A mechanism for the redistribution of oxygen isotopes, which describes the role of the processes of formation and decomposition of ozone, is proposed. The isotope effect on the photosynthesis of ozone is obtained from the material balance: $\alpha_\Sigma = \alpha_{form}[1 + \Delta(\alpha_{disin} - 1)]$, where α_{form} is the total isotopic effect during ozone formation, α_{disin} is the total isotopic effect during ozone disintegration, and Δ is the degree of ozone disintegration. (tr-auth)

187 DEUTERON QUADRUPOLE COUPLING CONSTANTS OF HYDROGEN-BONDED SYSTEMS. Olympia, P. L. Jr.; Fung, B. M. (Tufts Univ., Medford, Mass.). J. Chem. Phys., 51: 2976-80(Oct. 1, 1969).

A discussion of the electron distribution in the hydrogen-bond system, $O_1-D\cdots O_2$, in relation to the first-order density matrix and the deuteron quadrupole coupling constant (DQCC), is presented. It is shown that the valence-bond wavefunction of Coulson and Danielsson is only qualitatively useful. For the computation of the DQCC, a four-electron, three-basis orbital model appears to be inadequate. Theoretical values for DQCC which are somewhat comparable to experiment over a certain range of hydrogen-bond length, $O_1\cdots O_2$, is presented. These values are obtained with a 13-electron molecular-orbital model with sp^3 hybrid orbitals. On the basis of the theoretical results the relation between the isotope effect and the DQCC is discussed. The empirical relationship between DQCC and the $D\cdots O_2$ bond distance proposed by Soda and Chiba and the effect of hydrogen-bond symmetry on DQCC are also examined. (auth)

188 EFFECTIVE IONIC RADII IN OXIDES AND FLUORIDES. Shannon, R. D.; Prewitt, C. T. (E. I. du Pont de Nemours and Co., Wilmington, Del.). Acta Crystallogr., Sect. B, 25: 925-46 (1969).

An empirical set of "effective" ionic radii was compiled by the use of techniques similar to those of Goldschmidt. The actual radius values were derived from: 1000 experimental interatomic distances and an approximately linear relationship between ionic volume and unit cell volume of over 60 isotypic series of oxides and fluorides. These radii take into account electronic spin state and the coordination of both cations and anions and were found to reproduce closely the experimental interatomic distances in most oxides and fluorides. The choice of absolute values for anion radii and certain deviations from additivity are important and must be taken into consideration. (auth)

189 MECHANISM OF OXIDATION OF SCHIFF BASES TO OXAZIRANES BY PEROXY ACIDS IN VARIOUS SOLVENTS.

Madan, Vershal; Clapp, Leallyn B. (Brown Univ., Providence). J. Amer. Chem. Soc., 91: 6078-83(Oct. 22, 1969).

Hammett ρ values for peroxybenzoic acid oxidation of two series of Schiff bases, para-substituted N-benzal-t-butylamines and N-p-nitrobenzal-substituted benzylamines, were found to be −1.75 and −0.98, respectively. The ρ value for substituted peroxybenzoic acids as oxidizing agent was +0.78 and for substituted benzoic acids as catalyst was +0.22. The small solvent kinetic isotope effect, activation parameters in one case along with the ρ values, suggested a concerted mechanism pictured as a nucleophilic displacement of the C=N bond of the Schiff base on the peroxy oxygen. (auth)

190 METALLOCENYL CARBONIUM IONS. PARTICIPATION BY FERROCENE IN THE SOLVOLYSIS OF β-FERROCENYLALKYL TOSYLATES. Nugent, Maurice J.; Carter, Robert E.; Richards, John H. (California Inst. of Tech., Pasadena). J. Amer. Chem. Soc., 91: 6145-51(Oct. 22, 1969).

The participation of the ferrocenyl group during solvolysis of β-ferrocenylalkyl tosylates was demonstrated by (a) the entropy of activation, (b) the difference in solvolysis rate in acetic acid and 80% aqueous acetone, (c) the effect of methyl substitution on the α-carbon, (d) the kinetic isotope effect in the solvolysis of 1,1-dideuterio-2-ferrocenylethyl tosylate, and (e) the complete retention of configuration in the solvolysis of optically active 1-ferrocenyl-2-propyl tosylate. (auth)

191 THE MECHANISM AND MICELLAR CATALYSIS OF THE ACID CLEAVAGE OF α-PHENYLVINYL DIETHYL PHOSPHATE. Bunton, C. A.; Robinson, L. (Univ. of California, Santa Barbara). J. Amer. Chem. Soc., 91: 6072-7(Oct. 22, 1969).

The acid cleavage of α-phenylvinyl diethyl phosphate follows an A-Se2 mechanism. Plots of log k_ϕ against $-H_0'$ are linear with slopes 1.07 to 1.4 for hydrochloric, perchloric, and sulfuric acids, with $-\phi = 0.2$ to 0.6. In moderately concentrated acid the Arrhenius parameters depend on both acidity and temperature, but in dilute acid $\Delta S^* = -8.8$ eu, $k_{H_2O}/k_{D_2O} = 2.5$, and the positive salt effect of $LiClO_4$ is greater than that of LiCl, although $LiClO_4$ "salts in" and LiCl "salts out" the substrate. At concentrations above the cmc, sodium lauryl sulfate is an effective catalyst of the acid cleavage and $k_{H_2O}/k_{D_2O} \approx 2.2$. The catalysis is inhibited by cations with the rate sequence no salt > Li^+ > Na^+ > $(CH_3)_4N^+$. (auth)

192 pH–PRODUCT AND pH-RATE PROFILES FOR THE HYDROLYSIS OF METHYL ETHYLENE PHOSPHATE. RATE-LIMITING PSEUDOROTATION. Kluger, Ronald; Covitz, Frank; Dennis, Edward; Williams, L. David; Westheimer, F. H. (James Bryant Conant Lab., Cambridge, Mass.). J. Amer. Chem. Soc., 91: 6066-72(Oct. 22, 1969).

The hydrolysis of methyl ethylene phosphate in dilute acid solution has previously been shown to occur both with ring opening and with cleavage of the exocyclic methyl group, whereas the methyl ester of propylphostonic acid reacts under these conditions only with ring opening. These facts had been correlated with the theory that hydrolysis of the exocyclic methoxyl group takes place only after pseudorotation about the central phosphorus atom. The percent exocyclic cleavage for methyl ethylene phosphate in H_2O and D_2O is reported. The drop in the percentage of exocyclic cleavage in strongly acid solution may be correlated with rate-limiting pseudorotation; the rise in the percentage of exocyclic cleavage in strong alkali may be correlated with the ionization of both the hydroxyl groups in the pentacovalent intermediate so as to produce two O^- groups; according to theory, these should occupy equatorial positions, and so the ionization could force a pseudorotation that promotes exocyclic cleavage. The kinetic equations for the overall process exhibit unusual features that are discussed. (auth)

193 A PROTON RESONANCE INVESTIGATION OF EQUILIBRIA, SOLUTE STRUCTURES, AND TRANSAMINATION IN THE AQUEOUS SYSTEMS PYRIDOXAMINE–PYRUVATE–ZINC(II) AND –ALUMINUM(III). Gansow, O. S.; Holm, R. H. (Massachusetts Inst. of Tech., Cambridge. Rice Univ., Houston, Tex.). J. Amer. Chem. Soc., 91: 5984-93(Oct. 22, 1969).

As part of a proton resonance investigation of the mechanism of nonenzymatic transamination, the pmr spectra of systems initially containing 0.1 M pyridoxamine and 0.1 M pyruvate in the presence and absence of 0.05 M Zn(II) and Al(III) in D_2O solution at pD 1 to 13 were examined. Formation of the ketimine Schiff base, pyruvidene-N-pyridoxamine, in the metal-free system and complexes containing one and two complexed ketimine species are observed. Both free and complexed ketimine undergo H−D exchange at the pyruvidene methyl carbon. The presence of metal ions effects greater stabilization of ketimine over a wider pD range, due to complexation, compared to the metal-free system. Exchange between coordinated and free ketimine in the Zn(II) system is fast on the pmr time scale and slow in the Al(III) system. Certain of the acid-base equilibria of free ketimine and the Zn(II) and Al(III) complexes were investigated using the pD dependencies of chemical shifts. The Zn(II) and Al(III) ketimine complexes convert at rates which qualitatively increase with increasing pD to new species which were definitely identified by their characteristic pD dependencies of chemical shifts to be the corresponding aldimine complexes produced by transamination. The results of this study together with those of a previous investigation of pyridoxal−alanine−Zn(II) and −Al(III) systems serve to provide further definition of the course of nonenzymatic transamination and, therewith, offer strong confirmatory evidence for the proposed mechanism of this reaction. (auth)

194 INFLUENCE OF THE ALKALINE EARTH CHLORIDES ON THE STRUCTURE OF WATER. Greyson, Jerome; Snell, Harriet (North American Rockwell Corp., Canoga Park, Calif.). J. Phys. Chem., 73: 3208-14(Oct. 1969).

Entropies of transfer between heavy and normal water for $MgCl_2$, $CaCl_2$, $SrCl_2$, and $BaCl_2$ were determined from combination of free energies of transfer obtained from cell measurements with heats of transfer obtained from calorimetric measurements. The free energy and heat values indicated a spontaneous and exothermic transfer of the salts from D_2O to H_2O. Solvent−structure influence, established from the sign and magnitude of the entropy, indicated that the alkaline earth chlorides behave as structure-breaking salts. The order of structure-breaking influence for the cations was found to be $Ba^{2+} > Sr^{2+} > Ca^{2+} > Mg^{2+}$ with Mg^{2+} behaving as a structure maker. The structure influence of the cations was attributed to their long-range interaction with the bulk solvent. (auth)

195 EFFECT OF HYDROGEN BONDING ON THE BARRIER TO ROTATION ABOUT AMIDE BONDS. Neuman, Robert C. Jr.; Woolfenden, Warner R.; Jonas, Violet (Univ. of California, Riverside). J. Phys. Chem., 73: 3177-80(Oct. 1969).

The activation parameters for C−N rotation in N,N-dimethylacetamide and N,N-dimethylacetamide-d_3 were determined as a function of concentration in the solvent formamide. These data and the NMR spectral properties for these systems indicate that hydrogen bonding between dimethylamides and formamide stabilizes the planar ground state leading to higher rotational barriers. (auth)

196 ISOTOPIC EXCHANGE OF BROMINE IN $[Pt(DMSO)Br_3]^-$ IONS. Kukushkin, Yu. N.; Kuz'mina, M. A. Radiokhimiya, 11: 358-9(1969). (In Russian).

In the process of isotopic exchange between potassium bromide and $[Pt(DMSO)Br_3]^-$ ions, all of the bromine atoms in the ion are exchanged instantaneously. (M.C.G.)

197 SEPARATION, CONCENTRATION, AND DETERMINATION OF THE VALENCE FORMS OF PLUTONIUM(III, IV, AND VI) BY COPRECIPITATION WITH THE HYDRATED OXIDES OF ZIRCONIUM AND IRON. Novikov, A. I.; Starovoit, I. A. Radiokhimiya, 11: 339-41(1969). (In Russian).

The beginning and increase of coprecipitation of microquantities of plutonium with the hydroxides of zirconium and iron for the different valence forms of plutonium on increasing pH take place in the following order: Pu(IV), Pu(III), and Pu(VI). The concentration of valence forms of plutonium by coprecipitation with zirconium hydroxide is possible in the pH range 1.5 to 2.2 for Pu(IV), pH = 3.2 to 6.1 for Pu(III), and pH > 7.5 for Pu(VI). (tr-auth)

198 ELECTROMIGRATION METHOD FOR STUDYING COMPLEX FORMATION OF U(VI) WITH EDTA. Stepanov, A. V.; Makarova, T. P. Radiokhimiya, 11: 290-5(1969). (In Russian).

Electromigration of hexavalent uranium in EDTA at an EDTA concentration of 0.69×10^{-3} M was studied at 20°C, $\mu = 0.1$, and $[UO_2^{2-}] \leq 10^{-6}$ M. It was found that under the given condition hydrogen-containing complexes are formed. The existence of some ions and their stability constants were determined. (tr-auth)

199 INVESTIGATION OF THE PROCESS OF CATHODE PRECIPITATION OF NEPTUNIUM COMPOUNDS ON METALS. III. THE MECHANISM OF ELECTRODEPOSITION OF NEPTUNIUM COMPOUNDS FROM AQUEOUS SOLUTIONS AND THE STRUCTURE OF CATHODE PRECIPITATES. Surin, V. M.; Stabrovskii, A. I.; Rachev, V. V. Radiokhimiya, 11: 295-300 (1969). (In Russian).

The potentials of titanium and nickel cathodes were measured in 0.01N HNO_3 solutions and in 0.01N HNO_3 solutions containing 2.1×10^{-4} moles/l of a mixture of the salts NpO_2NO_3 and $NpO_2(NO_3)_2$ in the range of current densities from 0 to 150 ma/cm². It was established that depolarization of the electrodes occurs at current densities from 10 to 80 ma/cm² in the presence of NpO_2^+ and NpO_2^{2+} ions. It is shown that the depolarization of cathodes in the process of electrolysis of nitrate solutions containing the salts of neptunium is caused by the course of initial electrode reactions in the

reduction of Np(VI), Np(V), and Np(IV) ions. Roentgenographic methods were used to study the structure of cathode precipitates of neptunium compounds and showed the structure to be identical to that of calcined NpO_2. It was concluded that the mechanism of electrodeposition of neptunium from aqueous solutions consists of the direct reduction of the NpO_2^+ to NpO_2. At definite conditions (low acidity of the solution and high current density) a secondary process consisting of hydrolysis of Np(IV) ions with the formation of $Np(OH)_4$ proceeds simultaneously with the other reaction. (tr-auth)

200 CHANGE OF VALENCE STATES OF PLUTONIUM IN SOLUTIONS OF NITRIC, HYDROCHLORIC, SULFURIC, AND PERCHLORIC ACIDS ON IRRADIATION BY ULTRAVIOLET LIGHT. Palei, P. N.; Nemodruk, A. A.; Bezrogova, E. V. Radiokhimiya, 11: 300-7(1969). (In Russian).

The photochemical activity of different valence states of plutonium was studied in solutions of nitric, hydrochloric, perchloric, and sulfuric acids on irradiation by ultraviolet light in air and carbon dioxide. In nitrate solutions Pu^{3+} was easily oxidized to Pu^{4+}, which was slowly oxidized to Pu^{6+}. In solutions of HCl, $HClO_4$, and H_2SO_4, Pu^{3+} was oxidized only to Pu^{4+}. The greatest stability to ultraviolet light was possessed by Pu^{4+} and Pu^{6+}; however, the latter is easily reduced to Pu^{4+} or Pu^{3+} on introduction into the solution of a series of compounds that act as reducing agents. (tr-auth)

201 A CONTRIBUTION TO THE ORGANOMETALLIC CHEMISTRY OF URANIUM: TETRA(ALLYL)URANIUM. Lugli, G.; Marconi, W.; Mazzei, A.; Paladino, N.; Pedretti, U. (Laboratori Riuniti Studi e Ricerche, Milan). Inorg. Chim. Acta, 3: 253-4(June 30, 1969).

The synthesis of tetra-allyl U, obtained from UCl_4 and C_3H_5MgBr, is described as follows: 163 ml of a molar solution of C_3H_5MgBr in ethyl ether was added very slowly (10 hr) to a suspension of 10.31 g of anhydrous UCl_4(27.1×10^{-3} mole) in 180 ml of ethyl ether cooled to −30°C. The mixture was stirred while keeping the temperature at −20 to −30°C, then filtered at −30°C, and the solvent removed under high vacuum. Pentane (80 ml, cooled to −40°C) was added to the dry residue and the mixture filtered again. The pentane solution was concentrated under a vacuum and cooled to −78°C or lower. Dark red crystals slowly formed, and were purified by recrystallization under the same conditions. Yield was 60% based on UCl_4. The complex was thermally unstable above −20°C and burned spontaneously in the air. Its ir spectra were in agreement with π-bonded allylic groups. Thermal decomposition and cleavage with H_2O gave the expected hydrocarbon products. Magnetic susceptibility measurements are described. Attempts to obtain new complexes by reaction of $(C_3H_5)_4U$ with cyclooctadiene or triphenylphosphine ligands were unsuccessful; in both cases the ligands were recovered unreacted. (BBB)

202 ELECTROCHEMICAL BEHAVIOR OF URANIUM. Shapovalov, E. T.; Gerasimov, V. V. At. Energ. (USSR), 27: 289-93(Oct. 1969). (In Russian).

Potentiostatic studies of natural uranium in different media (pH = 0 to 14) were carried out. The active uranium, on which cathodic process of hydrogen ions discharge is taking place, subjects to self-passivation due to oxide film growth on its surface. The self-passivation is followed by the potential drift in the positive values direction up to the values corresponding to the end of passive region. Transition to transpassivity is caused by dissolution of the oxide film. Potential current dependence in the transpassivity region is described by Tafel equation. An analysis of possible oxides dissolution reactions corresponding to this equation were carried out. (auth)

203 KINETICS OF REDUCTION OF NEPTUNIUM(VI) WITH DISODIUM ETHYLENEDIAMINETETRAACETATE IN AQUEOUS PERCHLORIC ACID. Shastri, Nirmal K.; Amis, Edward S. (Univ. of Arkansas, Fayetteville). Inorg. Chem., 8: 2484-6 (Nov. 1969).

Kinetics for the reduction of neptunium(VI) with disodium ethylenediaminetetraacetate was studied in aqueous perchlorate media. Stoichiometry, specific velocity constants, enthalpy of activation, and entropy of activation were determined. A possible mechanism, which explains the observed kinetics and the stoichiometry of the reaction, is suggested. (auth)

204 KINETICS OF REDUCTION OF NEPTUNIUM(VI) WITH OXALIC ACID IN AQUEOUS PERCHLORIC ACID. Shastri, Nirmal K.; Amis, Edward S. (Univ. of Arkansas, Fayetteville). Inorg. Chem., 8: 2487-9(Nov. 1969).

The kinetics for the reduction of neptunium(VI) with oxalic acid was studied in aqueous perchlorate media. The rate law for the reaction was found to be $(d[Np(V)]/dt) = (k\{[Np(VI)][\text{total oxalate}]/[H^+]\})$. Specific velocity constants and activation energy were determined. A possible mechanism, which explains the observed kinetics and the stoichiometry of the reaction, is suggested. (auth)

205 PLUTONIUM-DOKUMENTATION. Referate-Zeitschrift mit Anhang Transplutonium-Elemente. September 1969. Band 3, Heft 9. 250 Referate (Register-Nr. 2682-3174). (Plutonium-Documentation. Abstract Journal with Appendix on Transplutonium Elements. September 1969. Vol. 3, No. 9. 250 Abstracts (Register No. 2682-3174). Karlsruhe, Ger., Gesellschaft fuer Kernforschung m. b. H., 1969. 137p. (In several languages).

206 THE REACTION OF A MOLTEN SODIUM SPRAY WITH AIR IN AN ENCLOSED VOLUME. PART I. EXPERIMENTAL INVESTIGATION. Krolikowski, T. S. (Argonne National Lab., Ill.); Leibowitz, L.; Wilson, R. E.; Cassulo, J. C.; Stynes, S. K. Nucl. Sci. Eng., 38: 156-60(Nov. 1969).

Molten sodium (623 to 698°K) was injected by a pneumatic, piston spray-injector into a closed reaction chamber containing dry air or dry air−nitrogen mixtures. The rate of the pressure rise resulting from the sodium−air burning reaction was measured during the spraying interval. The pressure-rise rate was a measure of the reaction rate. The spray particle size had the most pronounced effect on the reaction rate, which increased as the particle size decreased. Increasing the spray velocity resulted in a modest increase in the reaction rate. The reaction rate decreased slowly as the oxygen content of the atmosphere was lowered until, at an oxygen concentration of 4 mole %, there was no visible burning. (See also ANL-7472.) (auth)

207 THE REACTION OF A MOLTEN SODIUM SPRAY WITH AIR IN AN ENCLOSED VOLUME. PART II. THEORETICAL MODEL. Krolikowski, T. S. (Argonne National Lab., Ill.); Leibowitz, L.; Ivins, R. O.; Stynes, S. K. Nucl. Sci. Eng., 38: 161-6(Nov. 1969).

A mathematical model was developed to predict the burning rate and burning temperature of a single spherical sodium particle moving through air or air depleted in oxygen. The model is based on the assumption that the reaction rate is controlled by the diffusion of oxygen to a combustion zone surrounding the particle. A quasi-steady state approach and an averaging technique were used to correlate the reaction rates of individual spray particles with the theoretical burning rate of a spray and the theoretical pressure rise in an enclosing volume. The theory correctly predicted the direction and magnitude of experimentally observed variations in reaction rate with respect to oxygen content, spray velocity, and particle size. The spray particle size was found to be the most important parameter when considering the sprayed sodium−air reaction. (See also ANL-7472.) (auth)

208 STUDIES ON THE METHOD OF CHEMICAL PROCESSING OF NUCLEAR FUEL. Kim, Jae Won (Inha Inst. of Tech., Inchon, Korea). J. Nucl. Sci. (Seoul), 9: 79-85(1969). (In Korean).

Electrolytic reduction tests of uranyl solution by the revised Excer cell and the horizontal mercury cell were conducted to compare their performances and operating details using synthetic uranyl sulfate solution. Apparent advantages of the mercury cell to the Excer cell were found in the reduction efficiency as well as in the efficient electrolyte circulation, as a result, 95% or more reduction was possible with the mercury cell. The catholyte contamination by eroded lead anode was almost negligible by the cation exchange membrane separating the anolyte and the catholyte. The electrolytic stripping of impurities in the feeding solution by the mercury cathode was precursorily tested during the reduction experiments. The stripping effect was fully noticeable but not complete in the present experiments. It was confirmed that the precipitation of uranous hydroxide was completed passing through the formation of the intermediate acid complex by the addition of alkali hydroxide to the uranous solution which was made by the horizontal mercury cell electrolytically. (auth)

209 ELECTROCHEMICAL STUDY OF THE SODIUM−GRAPHITE REACTION. Aronson, S.; Salzano, F. J. (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng., 38: 187-9(Nov. 1969).

Thin plates of well-annealed pyrolytic graphite were heated in liquid sodium at 650°C for ~20 hr in a helium atmosphere, in a sealed steel container. The only sodium−graphite phase identified in the samples by x-ray diffraction was the $C_{64}Na$ phase. The emf values obtained were not constant and increased with time. Results suggest that the difficulty in preparing sodium−graphite lamellar compounds results from their low thermodynamic stability. (M.C.G.)

210 HEPTAVALENT STATE OF NEPTUNIUM AND PLUTONIUM. Spitsyn, V. I.; Gelman, A. D.; Krot, N. N.;

Mefod'eva, M. P.; Zakharova, F. A.; Komkov, Yu. A.; Shilov, V. P.; Smirnova, I. V. (Inst. of Physical Chemistry, Moscow). J. Inorg. Nucl. Chem., 31: 2733-45(Sept. 1969).

In alkaline media Np(VI) is oxidized to the heptavalent state by O_3, oxygen compounds of hexa- and octavalent Xe, persulfate, periodate, hypochlorite and hypobromite ions, bismuthates and, electrolytically, on a platinum anode. The redox potential of the pair Np(VII)/Np(VI) in 1M alkaline solutions is in the range of 0.40 to 0.76 V. To obtain Pu(VII) in dilute alkaline solutions O_3 and $S_2O_8^{2-}$ ions can be used. In strong alkali Pu(VI) is also oxidized by hypochlorite, hypobromite, and perxenate ions. The redox potential of the pair Pu(VII)/Pu(VI) in 1M KOH is in the range of 0.76 to 1.24 V. Absorption spectra of alkaline solutions of Np(VII) and Pu(VII) are independent of the way they were taken and are practically unaffected by changing concentration of OH^- ions over a broad range. The color of solutions of Pu(VII) and Np(VII) in the visible part of the spectrum is in satisfactory agreement with the Lambert–Beer law. Np(VII) and Pu(VII) can be converted in alkaline solutions to the hexavalent state by means of numerous reducers. The stoichiometric evidence obtained for a number of reduction reactions confirms the monoelectronic metal transfer from hepta to hexavalent form. Compounds $[Co(NH_3)_6] \cdot NpO_5 \cdot 3H_2O$, $[Pt(NH_3)_5Cl]NpO_5 \cdot H_2O$, $Ba_3(NpO_5)_2 \cdot nH_2O$, $S_3(NpO_5)_2 \cdot nH_2O$ and $Ba_3(PuO_5)_2 \cdot nH_2O$ were obtained in a solid state. Some of their properties were studied. It was found that Np(VII) and Pu(VII) exist in alkaline media as NpO_5^{3-} and PuO_5^{3-} anions. The latter are an anionic form of amphoteric hydroxides. $MO_2(OH)_3 \cdot NpO_2(OH)_3 \cdot nH_2O$ was obtained in a solid state. Some peculiar properties of the heptavalent state of Np and Pu are discussed. (auth)

211 GROUND-STATE MOLECULAR CONSTANTS OF HYDROGEN TELLURIDE. Moncur, N. K.; Edwards, T. H. (Michigan State Univ., East Lansing). J. Chem. Phys., 51: 2638-40(Sept. 15, 1969).

The ground states of the five isotopic species $H_2{}^{130}Te$, $H_2{}^{128}Te$, $H_2{}^{126}Te$, $H_2{}^{125}Te$, and $H_2{}^{124}Te$ were analyzed by simultaneous least-squares fits of ground-state combination differences formed from the four bands $\nu_1 + \nu_3$, $\nu_2 + \nu_3$, $2\nu_1$, and $\nu_1 + \nu_2$. Values were obtained for the ground-state constants A, B, C, the four centrifugal distortion taus, and the empirical term H_K added to the second-order Hamiltonian, for each of these species. (auth)

Radiation and Nuclear Chemistry

Refer also to abstracts 166, 179, 262, 265, 277, 543, 611, 694, 1276, and 1471–1473.

212 (CEA-CONF-1298) PROGRESS IN CHEMISTRY UNDER RADIATION. Frejacques, C. (Commissariat a l'Energie Atomique, [Paris] (France)). [nd]. 9p. (In French). (CONF-90325-1). Dep. CFSTI (U. S. Sales Only).

From 14th Nuclear Conference, Rome, Italy.

The predictable development of radiation chemistry is favored by the reduction of the costs of irradiation along with the improvement and development of different sources. The principal sources of radiation are electron accelerators, ^{60}Co and ^{137}Cs sources, and nuclear sources. Examples are given of new applications of radiation chemistry to illustrate the specificity, the fast and continuous processing, and treatment at room temperature. (J.S.R.)

213 (ORNL-4422, pp 154-82) TRANSURANIUM-ELEMENT PROCESSING. (Oak Ridge National Lab., Tenn.).

Research is reported under the following headings: TRU operations, isolation and purification of TRU products, development of chemical processes, special projects, and transplutonium element research. (M.C.G.)

214 (ORNL-4422, pp 300-3) IRRADIATION EFFECTS ON HETEROGENEOUS SYSTEMS. (Oak Ridge National Lab., Tenn.).

The effects of γ radiation on various inorganic aquasols were studied. Aged hydroxide sols of the lanthanides were essentially unaffected. Irradiation of a freshly prepared $Eu(OH)_3$ sol produced some transient effects, primarily in electric conductivity; however, the stability of the sol was not detectably affected. (auth)

215 (ORNL-4437, pp 48-56) RADIATION CHEMISTRY. (Oak Ridge National Lab., Tenn.).

Developments are reported for studies on: pulse radiolysis of NO; use of CO to detect $O(^1D)$ in the pulse radiolysis of O_2; flash photolysis of water and oxygen-saturated water; flash photolysis of ice; reactivities of peroxysulfuric acids with H atom; primary yields of SO_4^- radicals in the radiolysis of aqueous H_2SO_4 solutions; and energy transfer and radiolysis of aliphatic carboxylic acids. (P.C.H.)

216 ESR STUDIES OF CARBOXYLIC ACID- AND ESTER-RADICAL ANIONS PRODUCED BY γ-IRRADIATION AT 77°K. Nakajima, Yukihiko; Sato, Shin; Shida, Shoji (Tokyo Inst. of Tech.). Bull. Chem. Soc. Jap., 42: 2132-6(Aug. 1969).

A series of monocarboxylic acids and esters were γ-irradiated at 77°K, either pure or in the rigid matrix of 2-methyltetrahydrofuran, and the products were examined by ESR spectroscopy. The spectra obtained in the pure state showed that the primary paramagnetic species in each case is the corresponding radical anion, $R-\dot{C}\begin{matrix}O-\\O-R'\end{matrix}$. In the rigid matrix, these characteristic spectra were obtained after illuminating the γ-irradiated sample with visible light at the expense of the spectra of trapped electrons. When ultraviolet light was used for the illumination, the spectra of the radical anions disappeared, but instead appeared the spectra of the radicals produced by the decomposition of the radical anions. The latter spectra were almost the same as those obtained by the direct photolyses of acids and esters. (auth)

217 METHOD FOR PRODUCING TERNARY COPOLYMERS. Fukui, Kenichi (to Sumitomo Chemical Co.). Japanese Patent 1969-11660. May 28, 1969. Filed Apr. 28, 1965.

By the method proposed, a variety of ternary copolymers of N-acyl-substituted ethylenimines, carbon monoxide, and low-grade olefins are produced easily. The method consists of irradiating a mixture of the three monomers mentioned. By selecting different kinds of the N-acyl-substituted ethylenimines and the low-grade olefins, a variety of the ternary copolymers is obtained. The N-acyl-substituted ethylenimines may be N-acetylethylenimine, N-acetyl-2-methylethylenimine, etc.; while, the low-grade olefins include ethylene, propylene, etc. The ionizing radiation may be x ray, electron-beam, alpha-ray, etc. The temperature may be −78 to 200°C, and the pressure is from ordinary pressure to 2000 atm. The products having ketone and amide bonds may be used for various purposes including plastics. (NSA of Japan)

218 EVIDENCE FOR MALONALDEHYDE IN SOLUTIONS OF CARBOHYDRATES IRRADIATED WITH GAMMA RAYS. Morre, Jean (Laboratoire de Radiobiologie du Service Veterinaire, Paris). Ann. Chim. (Paris), 4: 227-34(May-July 1969). (In French).

Solutions of the following carbohydrates were irradiated with ^{60}Co at a dose rate of 31 Krad/hr: glyceraldehyde, xylose, galactose, arabinose, ribose, glucose, mannose, fructose, maltose, lactose, sucrose, cellobiose, and raffinose. The 0.01M solutions were in pH 9.5 bicarbonate buffer equilibrated with air. At 48 hr after irradiation uv absorption studies showed the presence of malonaldehyde by the use of the thiobarbituric acid reaction. The spectrum for this dialdehyde in the reaction with thiobarbituric acid was identified by means of a maximum at 535 nm with a shoulder between 480 and 520 nm. It was also demonstrated by means of chromatography on silica gel (butanol, methanol, water, sodium hydroxide 37, 37, 20 ml, and 0.50 g or butanol, methanol, water, acetic acid: 37, 37, 20.5, and 5.5 ml). (BBB)

219 CHEMICAL CONSEQUENCES OF THE NUCLEAR PROCESS $^{81}Br(n,\gamma)^{82}Br$ IN $K_2ReBr_6-K_2ReCl_6$ MIXED CRYSTALS. Mueller, H.; Martin, S. (Univ., Freiburg i. B.). Inorg. Nucl. Chem. Lett., 5: 761-5(Sept. 1969).

Homogeneous $K_2ReBr_6-K_2ReCl_6$ mixed crystals were activated in a reactor thermal column, and the distribution of ^{82}Br was studied after separation of bromide by ion exchange and various hexabromochlororhenates(IV) by thin-layer chromatography. The bromide fraction of ^{82}Br was constant (11.5%); most of the remainder was in the form of $ReBrBr_5^{2-}$ and $ReBrCl_5^{2-}$, in proportions varying with the original bromine content. The results are analyzed in terms of collision theories, and support the disorder model. (UK)

220 ION RECOMBINATION IN γ-IRRADIATED NAPHTHALENE SOLUTIONS. Brocklehurst, B.; Russell, R. D. (Univ. of Sheffield, Eng.). Trans. Faraday Soc., 65: 2159-67(Aug. 1969).

Ultraviolet absorption spectroscopy shows that $C_{10}H_8^+$, $(C_{10}H_8)_2^+$, $C_{10}H_8^-$ and $C_{10}H_9$· are produced when solutions of naphthalene in hydrocarbon glasses at 77°K are irradiated with γ-rays. Thermoluminescence is produced on warming and is correlated with the presence of ions. The reaction between $C_{10}H_8^+$ and $C_{10}H_8^-$ gives monomer emission only, not excimer emission; therefore, electron transfer must take place before the ions come into contact; excimers are formed from the dimer cations. Addition of electron scavengers (SF_6, CO_2, O_2, N_2O, NO) partially quenches the emission and alters the fluorescence/phosphorescence ratio; N_2 and CF_4 have no effect. "Glow curves" are interpreted in terms of the distribution of ion separations; ion pairs trapped close together recombine first: luminescence in the later part of the glow curves is due to ion pairs with greater separations and these are more likely to be affected by scavengers. (auth)(UK)

221 DESIGN OF ETCHED FIGURES OF IRRADIATED AND RADIOACTIVE CRYSTALS OF K_2SO_4. Gromov, V. V. (Inst. of

Physical Chemistry, Moscow). Zh. Fiz. Khim., 43: 1865-6(July 1969). (In Russian).

The design of etched figures in γ-quanta-irradiated and β-radioactive crystals of potassium sulfate showed that both external and internal irradiation increase the concentration of defects in K_2SO_4 crystals. Changes of the substance take place under the action of ionizing radiation on the surface of K_2SO_4 resulting in orderly microcrystals and cavities. (tr-auth)

222 RADICALS INDUCED IN THYMINE AND SOME OF ITS DERIVATIVES BY IONIZING RADIATION AND THERMAL HYDROGEN ATOMS. Henriksen, Thormod (Norwegian Radium Hospital, Montebello). Radiat. Res., 40: 11-25(Oct. 1969).

Thymine and some of its derivatives were exposed to ionizing radiation, thermal hydrogen and deuterium atoms. The radicals induced were studied by ESR spectroscopy. Special attention was given to the formation and relative significance of the 5-thymyl radical. The 5-thymyl radical is formed either via a precursor radical or by a direct radical reaction. On exposure to hydrogen atoms an addition reaction takes place in the thymine-containing substances, whereas in dihydrothymine a corresponding abstraction reaction operates. These radical reactions can partly be hindered or intercepted by sulfur-containing substances. They are temperature-dependent with activation energies in the range 1 to 3 kcal/mole. In the thymine and thymidylic acid the 5-thymyl radical hardly accounts for more than up to approximately 25% of the resonances induced by ionizing radiation, whereas in thymidine and dihydrothymine the radical attains greater importance. The yield of radicals induced in thymine by ionizing radiation depends largely on the physical form of the sample. In freeze-dried or amorphous samples the yield was 3 to 4 times larger than that obtained for polycrystalline samples, suggesting that lattice imperfections and disorder are involved in radical trapping. (auth)

223 IONIC PROCESSES IN THE RADIOLYSIS OF NITROUS OXIDE. Hummel, R. W. (Atomic Energy Research Establishment, Wantage, Eng.). Chem. Commun., No. 17, 995-6(1969).

It was found that the addition of small amounts of SF_6 to N_2O before irradiation reduces the nitrogen yield by an amount that indicates that more than one nitrogen molecule is produced for each electron arising from the ionization of the N_2O. (auth)(UK)

224 RADIATION-INDUCED GEOMETRICAL ISOMERISATION OF STILBENE IN THE GAS PHASE AT 200°. Hearne, J. A. (Atomic Energy Research Establishment, Wantage, Eng.). Chem. Commun., No. 17, 989-90(1969).

It was found that the addition of 1% SF_6 to cis-stilbene has no effect on the initial G (cis-trans) value for γ radiolysis in the gas phase. (auth)(UK)

225 ENDOR IN IRRADIATED ACETYLGLYCINE AT 77°K. Piazza, R. E.; Patten, R. A. (Univ. of Massachusetts, Amherst). Mol. Phys., 17: 213-15(1969).

Observations of prominent ENDOR resonances in irradiated single crystals of acetylglycine are reported. Samples were grown from aqueous solution and irradiated at room temperature to a total dose of several million R. All measurements were made at 77°K. X-band ESR under conditions of partial saturation permitted detection of anisotropic ENDOR resonances occurring within the 8 to 25 MHz range, indicative of weak interactions that contribute to the ESR linewidth. In addition, distant ENDOR was clearly observable at 13.8 MHz. The results are interpreted as signifying a weak interaction between the unpaired $\bar{\lambda}$-electron spin distribution and the protons of the methyl group. (UK)

226 IONIC GRAFT COPOLYMERIZATION. VIII. HOMOPOLYMERIZATION OF β-PROPIOLACTONE BY RADICAL CATALYSTS IN THE PRESENCE OF ELECTRON ACCEPTORS AND APPLICATION TO GRAFT COPOLYMERIZATION. Shiota, Tetsuya; Hayashi, Koichiro; Okamura, Seizo (Kyoto Univ.). J. Appl. Polym. Sci., 13: 1749-65(Aug. 1969).

The polymerization of β-propiolactone (βPL) induced by radiation and by radical catalysts, the influences of radical inhibitors and electron acceptors on this polymerization, and graft copolymerization were studied. It was found that βPL was polymerized by benzoyl peroxide in the presence of electron acceptors such as maleic anhydride and acrylonitrile. This polymerization method was applied to graft copolymerization. The electron donative trunk polymer containing ether groups was heated with benzoyl peroxide or was irradiated by γ rays from ^{60}Co in the presence of maleic anhydride as the electron acceptor. βPL was added subsequently to form the graft copolymer. (auth)

227 INFLUENCE OF CHLOROORGANIC COMPOUNDS ON THE CROSSLINKING OF CIS-POLYBUTADIENE BY ^{60}Co γ-RAYS. Jankowski, Bohdan (Inst. of the Rubber Industry, Warsaw); Kroh, Jerzy. J. Appl. Polym. Sci., 13: 1795-9(Aug. 1969).

Studies were made on the effects of chloroorganic compounds, such as butyl chloride, chloroform, carbon tetrachloride, trichloroethylene, and pentachlorocyclopentadiene, on the radioinduced crosslinking of cis-polybutadiene. The results showed that the extent of radioinduced crosslinking of cis-polybutadiene increased with increasing content of chloroorganic compound. The density of crosslinking increased linearly with the radiation dose. The greater the content of chlorine in chloroalkanes the larger was their accelerating influence on the extent of crosslinking. (P.C.H.)

228 TEMPORAL CONVERSION CHANGES OF RADIATION GRAFTING OF POLY(TETRAFLUOROETHYLENE) WITH VINYL ACETATE. Mozisek, Maxmilian (Research Inst. SIGMA, Olomouc, Czech.). Jad. Energ., 15: 310-12(1969). (In Czech).

The effects of ionizing radiation on poly(tetrafluoroethylene) in connection with vinyl acetate resulted in grafted copolymer and homopolymer. The reaction course differed from the usual radiation polymerization owing to the solid phase present. The results of measurements showed an increase in conversion velocity which was approximately proportional to the surface area of the sample foil. (auth)

229 RADIOLYSIS OF THYMINE IN AERATED AQUEOUS SOLUTION. IDENTIFICATION OF ACETYLUREA AMONG THE SUBSTANCES PRODUCED. Teoule, Robert; Cadet, Jean (Centre d'Etudes Nucleaires, Grenoble, France). Compt. Rend., Ser. D, 269: 656-8(Aug. 4, 1969). (In French).

Acetylurea was identified among the products of the decomposition of thymine under the influence of gamma radiation from ^{60}Co in an aerated aqueous solution. On Whatman No. 1 paper, R_f is 0.52 in butanol–water (86–14); it is 0.64 in the system acetonitrile–buffered water (Na_2HPO_4, 0.2M; NaH_2PO_4, 0.2M) (85–15). Acetylurea is formed from the primary products of radiolysis and is not formed at very low flux (200 rads). (tr-auth)

230 EFFECT OF GAMMA RADIATION ON TANNED COLLAGEN. Mohanaradhakrishnan, V.; Ramanathan, N. (CLRI, Madras). Leather Sci. (Madras, India), 14: 347-59(1967).

Collagen fibres tanned in various ways were subjected to gamma rays at three different dose levels. The mean breaking length (MBL), extension at break, and shrinkage temperature (T_s) were determined before and after irradiation. The samples were also analyzed electron microscopically. The MBL, extension at break and T_s were decreased, in general, by irradiation and the decrease was progressive with dosage. The alterations in the fibrillar structure in tanned collagen caused by irradiation were compared with the physical and hydrothermal properties. 17 references. (Indian Sci. Abstr.)

231 RADICAL PAIRS IN IRRADIATED ORGANIC SOLIDS AS STUDIED BY EPR. Lebedev, Ya. S. (Inst. of Chemical Physics, Moscow). Radiat. Eff., 1: 213-27(Sept. 1969).

The experimental data concerning the pairwise generation of paramagnetic defects (radicals) for irradiation of organic solids are reviewed and discussed. Two main mechanisms of pair formation are shown to be of importance: (1) the disintegration of molecules into heavy fragments remaining inside the "cage" and (2) valence or charge transfer between the nearest molecules following the scheme: $RX \rightsquigarrow R + X$, $X + RX \rightarrow X_2 + R$. Analysis of EPR signals allows one to calculate the distances separating the radical sites as well as their relative orientations. In the case of mechanism (1), the inter-radical distances are exactly fixed and correspond to that of undamaged molecules, sometimes not only in molecular crystals but even in the frozen solutions. In case (2), the transfer mechanism permits the generation of a number of pairs differing by distance and orientations, and they are indeed observed, but the radiation yields of different pairs are very much different. The kinetic study of radiation-induced accumulation of pairs of the type (1) and isolated radicals suggests a simple scheme of radical formation through pairs as intermediate species: $M \rightsquigarrow |R \ldots R| \rightarrow 2R^{\cdot}$ and allows one to calculate the probabilities of escape from the cage and rate constants for radical reactions "in the cage." For the pairs of type (2) in γ-irradiated dimethylglyoxime, the kinetics of transition between the different pairs has been studied yielding information concerning the H-atom transfer from undamaged C:NOH groups to radical C:NO sites located at certain points of the crystalline cell. Some new unexpected effects observed in the course of investigation of radical pairs are also discussed briefly. The results demonstrate that the radical pair investigation is a new and interesting way to study radiation-induced defects and post-irradiation chemical reactions in solids. (auth)

232 ASPECTS OF RADIODENATURATION OF SOME NUCLEIC COMPONENTS. I. RADIODENATURATION OF PURINE AND PYRIMIDINE BASES. Uliana, Robert; Creac'h, Paul V. (Laboratoire de Biochimie de la Nutrition, Bordeaux). Bull. Soc. Chim. Fr., No. 8, 2904-8(Aug. 1969). (In French).

Aqueous and aerated solutions of purine and pyrimidine bases were irradiated by γ-rays of ^{60}Co. A systematic spectrophotometric investigation showed two different radiodenaturation patterns: 1) A strong denaturation (breaking of a purine ring or saturation of the C_5-C_6 double bond of a pyrimidine ring) of irradiated molecules corresponding to a decrease of the molecular extinction coefficient at the uv absorption maximum. 2) A modification of electron distribution as seen by localized modifications of the uv spectra of the irradiated bases. These two types of radiodenaturation depend on the degree of molecular ionization. (auth)

233 ASPECTS OF RADIODENATURATION OF SOME NUCLEIC COMPONENTS. II. RADIODENATURATION OF DNA DEOXYRIBONUCLEOSIDES. Uliana, Robert (Laboratoire de Biochimie de la Nutrition, Bordeaux). Bull. Soc. Chim. Fr., No. 8, 2903-12(Aug. 1969). (In French).

The radiosensitivity of DNA deoxyribonucleosides is compared with that of their respective bases. 1) DNA deoxyribonucleosides undergo two radiolytic denaturation patterns as do their bases: strong denaturation causes a complete or a partial destruction of the molecule; and a weaker denaturation detected by modifications in the energetic state of the original purine and pyrimidine rings. 2) The role played by the deoxyribose bonding to a base is studied after solutions of a deoxyribonucleoside and their corresponding bases are irradiated in the presence of an equimolecular quantity of deoxyribose. Deoxyribose bonding essentially protects the purine derivatives. In alkaline medium, it sensitizes the pyrimidine derivatives. (auth)

234 RADIOLYSIS OF TRIFLUOROIDOMETHANE IN THE GAS PHASE. McAlpine, I.; Sutcliffe, H. (Univ. of Salford, Eng.). J. Phys. Chem., 73: 3215-18(Oct. 1969).

The radiolysis of trifluoroiodomethane at 1 atm pressure in Pyrex glass vessels was examined. In vessels where the surface was conditioned by a preirradiation technique the products and 100-eV yields are tetrafluoromethane, 1.08; iodine, 0.13; and difluorodiiodomethane, 0.82. When the surface was not conditioned, yields were erratic and hexafluoroethane, carbonyl fluoride, and silicon tetrafluoride were also formed. Experiments in the presence of oxygen as a radical scavenger indicate that the reaction proceeds mainly by a radical process. (auth)

235 PRODUCTION AND REACTIVITY OF ^{11}C IN SOLID COMPOUNDS. Ache, Hans J.; Wolf, Alfred P. (Virginia Polytechnic Inst., Blacksburg. Brookhaven National Lab., Upton, N. Y.). J. Phys. Chem., 73: 3499-3502(Oct. 1969).

The chemical changes accompanying the reaction of energetic ^{11}C in alkali halides and aluminum metal were studied. The reaction $Na(p,x)^{11}C$ attained by a 3-GeV proton beam and the reaction $^{14}N(p,\alpha)^{11}C$ using 10-MeV protons were used to introduce the carbon recoil species into the solid. Data for the percentages of ^{11}C-labeled compounds obtained from alkali halides after dissolving the halide in water are tabulated. The presence of six different reaction products suggests that several ^{11}C-containing species must exist in the crystal. (D.H.M.)

236 IONIZATION OF LIQUIDS BY RADIATION STUDIED BY THE METHOD OF PULSE RADIOLYSIS. II. SOLUTIONS OF TRIPHENYLMETHYL CHLORIDE. Capellos, C. (Picatinny Arsenal, Dover, N. J.); Allen, A. O. J. Phys. Chem., 73: 3264-8(Oct. 1969).

Solutions of triphenylmethyl chloride in five solvents (n-hexane, cyclohexane, 2,2,4-trimethylpentane, carbon tetrachloride, and carbon disulfide) subjected to pulse radiolysis gave yields of triphenylmethyl carbonium ion equal within experimental error to the total yield of free ions in these solvents over the solute concentration range 10^{-3} to 10^{-2} M. The ion does not form in the presence of substances like alcohol which possess basic character. Kinetics of formation and decay of the ion were determined. (auth)

237 PARAMAGNETIC RELAXATION OF RADIATION-PRODUCED ELECTRONS IN ANNEALED GLASSY AND POLYCRYSTALLINE ALKALINE ICES. Hase, Hirotomo; Kevan, Larry (Univ. of Kansas, Lawrence). J. Phys. Chem., 73: 3290-3(Oct. 1969). (COO-1528-29).

Paramagnetic relaxation characteristics of e_t^- in γ-irradiated 10 M NaOH ices which were annealed at various temperatures prior to irradiation were studied. The spin–spin relaxation time and trapped electron yields depend on the annealing temperature and time, while the spin–lattice relaxation time remains constant. This indicates that electrons are always trapped in similar local environments which are most likely glassy regions in the ice. Variations in total and local electron concentrations and in relaxation times with the temperature are explained by a model of electrons escaping from polycrystalline to glassy regions in the ices. (auth)

238 IONIC REACTIONS IN GASEOUS MIXTURES OF MONOSILANE AND ETHYLENE. Beggs, D. P.; Lampe, F. W. (Pennsylvania State Univ., University Park). J. Phys. Chem., 73: 3315-22(Oct. 1969). (NYO-3570-8).

In ionized mixtures of monosilane and ethylene the only major ions that are observed to undergo collision reactions with the opposite molecule are $C_2H_2^+$, $C_2H_3^+$, and SiH_3^+. The principal reactions of both $C_2H_2^+$ and $C_2H_4^+$ are those involving H_2^- (or H and H^- in one step) abstraction from SiH_4. The principal reaction of SiH_3^+ with C_2H_4 is to form $SiCH_3^+$ and CH_3. Rate constants for all the reactions of $C_2H_2^+$ and $C_2H_4^+$ with SiH_4 and of SiH_3^+ with C_2H_4 are reported. Isotope labeling experiments indicate reactive intermediates in which complete mixing of hydrogen atoms takes place. The very fast reactions of $C_2H_4^+$ with SiH_4 and SiH_3^+ with C_2H_4 provide a rationale for the effects of C_2H_4 on the radiolysis of monosilane. (auth)

239 THERMAL AND NEUTRON IRRADIATION EFFECTS ON THE RATE OF RACEMIZATION OF d-$K_3Cr(C_2O_4)_3.2H_2O$ IN THE SOLID STATE. Chowdhury, D. M.; Harris, G. M. (State Univ. of New York, Buffalo). J. Phys. Chem., 73: 3366-9(Oct. 1969).

The compound d-$K_3Cr(C_2O_4)_3 \cdot 2H_2O$ undergoes thermal racemization in the solid state at temperatures exceeding 200°C, even when previously completely dehydrated at a lower temperature. However, the presence of water vapor greatly accelerates the process, as is to be expected, since studies of the racemization of this complex in solution indicate that water may very efficiently displace at least one end of chelated oxalate. Preirradiation of the optically active crystals by pile-generated neutrons causes inhibition of the racemization reaction perhaps as a result of some sort of defect annealing process or of lattice blockage by nuclear recoil debris. (auth)

240 EVIDENCE FOR DISCRETE CHANGES IN SOLVATION OF TRAPPED ELECTRONS IN RIGID MIXTURES. Sawai, Takashi; Hamill, William H. (Univ. of Notre Dame, Ind.). J. Phys. Chem., 73: 3452-6(Oct. 1969).

Trapped-electron optical absorption spectra for γ-irradiated mixed solvents at 77°K exhibit maxima at or near those for the pure components and other poorly resolved or unresolved structures at intermediate wavelengths. For mixtures of methanol (M) and methyltetrahydrofuran (F) the envelopes were decomposed into five component absorption bands. These are attributed to discrete solvation spheres containing M_4, M_3F, M_2F_2, MF_3, and F_4. The band for pure methyltetrahydrofuran (MTHF) itself is structured, the longer wavelength component with about 25% of the total oscillator strength decaying more rapidly on warm-up. The effect was attributed to two nearly equivalent orientations of one of the four solvating dipoles. 2-Propanol–3-methylpentane mixtures also provide evidence for strong interaction with one to four dipoles. The results do not support continuum models for electron solvation. (auth)

241 ON THE OCCURRENCE OF SIMULTANEOUS DOUBLE DISPLACEMENT IN HOT-HYDROGEN REACTIONS. Baker, R. T. K.; Wolfgang, R. L. (Univ. of Colorado, Boulder). J. Phys. Chem., 73: 3478-81(Oct. 1969).

Two general mechanisms for reaction by hot hydrogen to replace two atoms or groups are considered. In this connection the pressure dependence of the reaction of recoil tritium with ethane was measured. As expected, the methyl radical, $CH_3T\cdot$, was found to derive largely from the decomposition of excited ethane, $C_2H_5T^*$, formed by the familiar single-displacement process. However, a significant yield of ethyl radical, $C_2H_4T\cdot$, is also formed. The appearance and relative lack of pressure dependence of this product is consistent with, but does not prove, a direct or simultaneous double-displacement mechanism. A reexamination of earlier data does not support any conclusion that the direct double-displacement mechanism is negligible. The question of whether such a process occurs is still open, although it remains clear that this is not a major mode of hot-hydrogen reaction. (auth)

242 ELECTRODE REACTIONS INVOLVING ELECTRONICALLY EXCITED STATES OF MOLECULES. Hale, J. M. (Cyanamid European Research Inst., Geneva). J. Phys. Chem., 73: 3196-3201(Oct. 1969).

Calculations are presented concerning two aspects of the electrode reactions of molecules M* in electronically excited states. Firstly, the current which would flow through an electrode is computed for the experimental arrangement in which M* is generated by irradiation of a solution of the ground-state molecules M through the electrode, which is assumed to be potentiostatically controlled in a region of potential where only M* is electroactive. Secondly, the rate of electrogeneration of M* is calculated, assuming the potential of the electrode to be switched instanta-

neously from one at which an anion M^- is formed at a diffusion-controlled rate to one at which oxidation of M^- to M^* is feasible. In each calculation the quenching of M^* to M by electron exchange with the electrode is allowed for by using for this purpose a recently derived formulation of an electrochemical rate constant valid at high overpotentials. (auth)

243 STUDIES ON IODINE AS A SCAVENGER IN IRRADIATED HYDROCARBONS AND HYDROCARBON–ALCOHOL SOLUTIONS. Johnsen, Russell H.; Barker, Norman T.; Burgin, Mary (Florida State Univ., Tallahassee). Contract AT(40-1)-2001. J. Phys. Chem., 73: 3204-8(Oct. 1969). (ORO-2001-9).

The yield of those species produced in x-irradiated hydrocarbon–iodine solutions which give rise to I_3^- upon the subsequent addition of ethanol was measured. While it has been generally assumed that I_2 reacts with thermal hydrogen atoms, it is suggested that in fact I_2 reacts preferentially with electrons and that $G(I_3^-) = G(e^-)$. This view is in part suggested by the behavior of solutions to which alcohols are added prior to irradiation. The extrapolated yields of $G(I_3^-)$ in n-hexane, cyclohexane, and 3-methylpentane are 2.42, 1.94, and 1.56, respectively. (auth)

244 CHEMICAL BEHAVIOR OF RADIOACTIVE ATOMS OF RHENIUM IN THE PROCESS OF THERMAL ANNEALING OF CRYSTALS OF NH_4ReO_4, IRRADIATED BY PROTONS WITH AN ENERGY OF 660 MeV. Zaitseva, N. G.; Ianovich, E.; Raicheva, V. Radiokhimiya, 11: 366-70(1969). (In Russian).

The behavior of Re^{4+} and Re^{7+} on thermal annealing depends on the temperature and time of annealing and on the radiation dose obtained by the crystal. On comparison of the results of thermal annealing of irradiated ammonium perrhenates with previous data from sodium perrhenates, different behavior of atoms of radioactive rhenium in relation to the nature of the cation was discovered. (tr-auth)

245 PECULIARITIES OF LOOP PRODUCTION OF BERKELIUM IN REACTORS. Bak, M. A.; Krivokhatskii, A. S.; Romanov, Yu. F.; Shiyamin, E. A. Radiokhimiya, 11: 325-9(1969). (In Russian).

The production of ^{249}Bk by neutron irradiation of a ^{244}Cm target is described. A method for continuous isolation of berkelium from the zones of irradiation, based on the possibility of its existence in the tetravalent state in contrast to the trivalent state of the target element, is described. (M.C.G.)

246 EFFECT OF GAMMA RAYS ON PYRIMIDINES. ISOLATION AND IDENTIFICATION OF A NEW SUBSTANCE OBTAINED BY RADIOLYSIS OF THYMINE: 5-METHYL-5-HYDROXYHYDANTOIN. Teoule, Robert; Cadet, Jean (CEN, Grenoble, France). Compt. Rend., Ser. D, 268: 2501-3(May 19, 1969). (In French).

From kinetic experiments concerned with a study of the effects of γ radiation on thymine in aerated aqueous solution it has been shown that the two most important relatively stable radioproduced products are the 5,6-glycol of thymine (cis and trans form) and an unknown substance. This unknown compound migrates in the system butanol–water (86:14) on Whatman No. 1 paper at Rf = 0.44 ($R_{thymine}$ = 0.89). It was isolated by chromatography in quantity sufficient for a spectral study. Mass, NMR, uv, and ir spectra and other chemical considerations made it possible to identify this compound as 5-methyl-5-hydroxyhydantoin. (tr-auth)

247 EXPERIMENTAL ASPECTS OF POLYMER IRRADIATIONS. Makhlis, F. A. At. Energ. (USSR), 27: 323-30 (Oct. 1969). (In Russian).

Some experimental and specific aspects are discussed regarding the use of polymeric materials in nuclear and space engineering. The basic differences in radioinduced end-effects in crystalline and amorphous states are discussed. An indication is given to the importance of post-radiation changes in polymers. Control of radiation damage by proper regulation of environmental conditions particularly the oxygen content is emphasized. Evaluation of polymer deterioration based on tests with all the factors examined separately may result in errors. The temperature effect on polymers before, during, and after irradiation is different. Similarly polymer deterioration on vacuum irradiation may vary depending on whether the vacuum is maintained during irradiation or if it was built up before the test. Direct measurement of polymer damage with all the space environmental factors such as vacuum, uv-rays, nuclear radiation, and extreme temperatures acting at the same time is one of the most vital set of difficult problems in radiation polymer engineering. Particular attention is centered on the discrepancy between experimental values obtained in polymer irradiations. (auth)

248 CHEMICAL FORMS OF IODINE IN CARRIER FREE PREPARATIONS OF $Na^{131}I$. Cvoric, Jelisavka (Boris Kidric Inst. of Nuclear Sciences, Vinca, Yugoslavia). J. Chromatogr., 44: 349-61(Oct. 28, 1969).

Various forms of iodine were separated chromatographically and their R_F values determined. The formation of unidentified components in the system: $^{131}I^-/I_2$, $^{131}I^-/IO_3^-$, $^{131}I^-/IO_4^-$, was investigated as a function of the concentration of the reagent, the pH of the medium, the aging time of the solution and the temperature, by employing a paper chromatographic method. (auth)

249 COMPARATIVE EVALUATIONS OF BEHAVIOR OF SOME FLUOROCARBON RESINS UNDER ^{60}Co GAMMA IRRADIATION. Ferse, A. Plaste Kaut, 15: 473-7(July 1968). (In German).

The changes in the elongation and the tensile strength, the hardness and the zero strength time (ZST) values of hexafluoropropene–tetrafluoroethylene copolymers and hexafluoropropene–vinylidene fluoride copolymers under the influence of ^{60}Co γ radiation were measured and compared with corresponding values for γ-irradiated polytetrafluoroethylene. From the changes in these values, the kinds of reactions in the irradiation can be determined. (M.C.G.)

250 FLUORESCENCE IN THE NANOSECOND PULSE RADIOLYSIS OF DIOXAN. Baxendale, J. H.; Beaumond, D.; Rodgers, M. A. J. (Univ. of Manchester, Eng.). Chem. Phys. Lett., 4: 3-4(Sept. 15, 1969).

The pulse radiolysis of dioxan produces a fluorescing excited state of dioxan (λ_{max} = 245 nm) with lifetime 2 to 3 nsec which gives rise to the singlet excited state of solute anthracene with almost the same yield. G = 1.4/100 eV, as is found in benzene solutions. No analogous emission is observed with tetrahydrofuran and it is concluded that the small yields of excited states observed in this and some other solvents arise from the absorption of Čerenkov radiation. (auth)

251 RADIATION-INDUCED COPOLYMERIZATION OF MALEIMIDES AND ACENAPHTHYLENE IN THE SOLID STATE. Yamakita, Hiromi; Hayakawa, Kiyoshi (Government Industrial Research Inst., Nagoya, Japan). J. Appl. Polym. Sci., 13: 1833-43(Sept. 1969).

The γ-induced polymerizations in the binary systems of maleimide–acenaphthylene and N-methylmaleimide–acenaphthalene were studied. The phase diagrams of the two systems show that a eutectic was found in each system. It was proved by the solvent extraction and the turbidimetric titration of polymer obtained that copolymer was formed in the eutectic of each system together with homopolymers. The fraction of total homopolymers in the maleimide–acenaphthylene system was nearly the smallest in the monomer mixture of the eutectic composition. The composition of the copolymer, which was isolated by the extractions, was almost independent of the monomer composition. In order to elucidate these results, it was postulated that the copolymerization occurred at grain boundaries between the two components in the eutectic. (auth)

252 PULSE RADIOLYSIS. Matheson, Max S.; Dorfman, Leon M. M.I.T. Press Research Monographs in Radiation Chemistry. Volume 1. Cambridge, Mass., Massachusetts Institute of Technology Press, 1969. 211p. $11.75.

Pulse radiolysis is considered under the headings of elementary reactions in radiation chemistry; pulsed radiation sources; detection methods; dosimetry; kinetic equations and treatment of the data; aqueous systems; reactions of the hydrated electron; organic systems; and gaseous systems. (D.H.M.)

253 RADIATION CHEMICAL STUDIES OF PROTEIN REACTIONS: EFFECT OF POST-IRRADIATION ON VISCOSITY. Nisizawa, Mizuho (Defense Academy, Yokosuka, Japan). J. Appl. Polym. Sci., 13: 1895-7(Sept. 1969).

Protein was irradiated by γ radiation, a ^{60}Co source. At different times after irradiation, the reactivity decay of the irradiated protein was examined. An empirical equation for the reactivity decay was observed. (auth)

254 PREPARATION OF CARRIER-FREE ^{55}Fe AND ^{59}Fe BY REACTOR IRRADIATION. O'Brien, H. A. Jr. (Oak Ridge National Lab., Tenn.). Int. J. Appl. Radiat. Isotop., 20: 711-15 (Oct. 1969).

Millicurie quantities of carrier-free ^{55}Fe and ^{59}Fe were obtained from irradiated cobalt and nickel targets. The fission-neutron cross sections were determined to be 3.30 ± 0.39 mb for the $^{58}Ni(n,\alpha)^{55}Fe$ reaction, 1.06 ± 0.12 mb for the $^{59}Co(n,p)^{59}Fe$ reaction, and 0.111 ± 0.013 mb for the $^{62}Ni(n,\alpha)^{59}Fe$ reaction based on a value of 61 mb for the $^{54}Fe(n,p)^{54}Mn$ reaction. The uncertainties quoted are the standard errors at the 95% confidence level. (auth) (UK)

255 STUDY BY METHOD THE ELECTRON PARAMAGNETIC RESONANCE OF ACTION OF THE GAMMA-IRRADIATION

ON PHOTOCHROME GLASSES. Galimov, D. G.; Stepanov, S. A.; Tsekhomskii, V. A.; Yudin, D. M. Izv. Akad. Nauk SSSR, Neorg. Mater., 5: 1392-6(Aug. 1969). (In Russian).

Electron paramagnetic resonance was used to study the effects of γ radiation on the redox state of the AgCl–Cu system. The optical spectra of glasses at various stages of the treatment were also considered. Metallic silver particles were formed by γ irradiation of the glasses by the initial process, which resulted in the isolation of AgCl crystals. An increase in temperature led to the formation of AgCl and to the disappearance of the particles of metallic silver. The Cu ions participate in the formation of AgCl by giving up or taking electrons from silver. (tr-auth)

Radiochemistry

Refer also to abstracts 1, 235, and 248.

256 CHEMICAL FORMS OF ^{13}N PRODUCED BY $^{14}N(n,2n)$ REACTION IN SOLID POTASSIUM AND SODIUM CYANIDES. Kuhry, Jean Georges (Centre de Recherches Nucleaires, Strasbourg). Bull. Soc. Chim. Fr., No. 8, 2641-3(Aug. 1969). (In French).

Solid samples of sodium and potassium cyanides were irradiated in a fast neutron flux. The activity of ^{13}N produced by the $^{14}N(n,2n)$ reaction is distributed among three forms after dissolution of the targets: molecular nitrogen (31.5%), $C^{13}N^-$ (38%) and $^{13}NCN^=$ (30.5%). Thermal annealing increases the yield of $C^{13}N^-$ at the expense of cyanamide. Several reaction mechanisms are proposed: hot substitution collisions, addition or insertion reactions, and processes occurring in the hot zone. (auth)

Separation Processes

Refer also to abstracts 17, 21, 27–33, 174, 179, 208, 319, 413, 455, 457, 461, 483, 982, 984, 1963, and 2016.

257 (ANL-7575) CHEMICAL ENGINEERING DIVISION ANNUAL REPORT, 1968. (Argonne National Lab., Ill.). Apr. 1969. Contract W-31-109-eng-38. 180p. Dep. CFSTI.

Seven sections are included; an abstract was prepared for each. (P.C.H.)

For abstracts of individual sections see: 174, 175, 258, 1309, 1775, 1996, and 2004.

258 (ANL-7575, pp 19-46) COMPACT PYROCHEMICAL PROCESSES. Steunenberg, R. K.; Arntzen, J. D. (Argonne National Lab., Ill.).

Research on compact pyrochemical processes for the recovery of U and Pu from fast breeder reactor fuels is reported. Chemical studies in support of pyrochemical process development have included measurements of the distribution of Np between molten mixtures of KCl–$MgCl_2$–NaCl and Mg–Zn alloys; measurement of the solubilities of Pu in liquid Mg–Zn alloys, Cr in liquid Zn, and of Np in liquid Cd; determination of the liquidus composition-temperature relationships for the $MgCl_2$–MgF_2 and $CaCl_2$–CaF_2–CaO systems; and a determination of the activity of Np in liquid Cd–Np alloys. A conceptual flowsheet was prepared for the pyrochemical processing of one ton per day of short-cooled fuel from a fast breeder reactor. Experiments were performed to study the removal of stainless steel cladding from UO_2 fuels and subsequent reduction of the oxide. Mixer-settlers were selected for use in the plutonium decontamination steps of the salt transport process. An existing induction furnace was modified for use as a vacuum retort to evaporate solvent metals from solutions containing Pu and U. A materials testing program is being conducted to evaluate the suitability of various materials of construction for process applications. Emphasis is being placed on materials to be used with Cu–Mg alloys and zinc and Mg–Zn alloys. A mixer-settler design was tested by experiments which were performed to demonstrate the transport of uranium via a salt phase from a metal alloy in one mixer-settler to another alloy in a second mixer-settler, and to determine if any of the metal phase is entrained in the salt. (J.G.B.)

259 (ANL-Trans-775) PRESENT PROGRAM AND FUTURE DEVELOPMENT OF THE PLUTONIUM CHEMISTRY GROUP OF THE CHEMISTRY AND ISOTOPE DIVISION. Ruiz Sanchez, F. Translated for Argonne National Lab., Ill., from pp 143-6 of Compte Rendu du Ier Colloque Franco-Espagnol sur le Traitment des Combustibles Irradies, Fontenay-aux-Roses, France, 11–14 Novembre 1967. 5p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 47605.

260 (ANL-Trans-776) SEPARATION OF URANIUM, PLUTONIUM, AND FISSION PRODUCTS BY SYNTHETIC INORGANIC ION EXCHANGERS. Rodriguez Parra, M.; Uriarte Hueda, A.; Lopez Perez, B. Translated for Argonne National Lab., Ill., from pp 201-20 of Compte Rendu du Ier Colloque Franco-Espagnol sur le Traitment des Combustibles Irradies, Fontenay-aux-Roses, France, 11–14 Novembre 1967. 15p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 47609.

261 (ARH-1346) RECOVERY OF PALLADIUM FROM NUCLEAR WASTE SOLUTIONS USING A PACKED COLUMN OF TRICAPRYL MONOMETHYL AMMONIUM CHLORIDE ON AN INERT SUPPORT. Colvin, C. A. (Atlantic Richfield Hanford Co., Richland, Wash.). Sept. 1969. Contract AT(45-1)-2130. 10p. Dep. CFSTI.

Palladium is present in supernatant solutions in the high-salt wastes that were stored following the recovery of actinides from irradiated uranium. A particular means to isolate palladium from waste solutions was demonstrated. Palladium is preferentially retained on a packed column of Aliquat-336 (tricaprylmonomethylammonium chloride) fixed on an inert support. A homogeneous powder, uniformly coated with the amine extractant, is prepared by dissolving Aliquat-336 in xylene, mixing with Plaskon (a trifluorochloroethylene polymer), and volatilizing the xylene. The powder, mixed with asbestos (flow rate aid), was packed in an 8-mm column. High-salt basic waste solution was passed through the column until 50% palladium breakthrough, resulting in 13.3 mg of palladium present on the 446 mg of Aliquat-336. Elution was accomplished by cycles of 8.0M HNO_3 and 1.5M NH_4OH. The first cycle of 8.0M HNO_3 resulted in the recovery of 56% of the palladium in 35 ml of eluent (0.22 g/liter Pd). The first cycle of 1.5M NH_4OH recovered an additional 25% in 30 ml of eluent. The total recovery of palladium from the column in three complete elution cycles was 98%. Effective separation of the palladium from rhodium was evident. (auth)

262 (EURFNR-663) INFLUENCE OF THE RADIOLYSIS OF TRIBUTYL PHOSPHATE ON THE PLUTONIUM YIELD IN THE PUREX PROCESS FOR HIGH PLUTONIUM CONTENT. Stieglitz, L.; Ochsenfeld, W.; Schmieder (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Heisse Chemie). Translation of report KFK-691. 31p. Dep. CFSTI.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

Irradiations were carried out to study the formation of dibutyl phosphate from TBP in the Purex Process and to determine the effects of the dibutyl phosphate on plutonium recovery by this process. The presence of an aqueous phase and oxygen during irradiation seemed to have a major influence on the radiolytic decomposition. The plutonium retention after the fourth and fifth back-washings was proportional to the radiation dose and directly related to the dibutyl phosphate concentration. (M.C.G.)

263 (IN-1322) POST-CALCINATION TREATMENT POSSIBILITIES FOR CALCINE FROM FLUIDIZED BED CALCINATION. Rhodes, D. W. (Idaho Nuclear Corp., Idaho Falls). Sept. 1969. Contract AT(10-1)-1230. 16p. Dep. CFSTI.

The dry, granular calcine produced by fluidized-bed calcination of highly radioactive waste in the Waste Calcining Facility at the Idaho Chemical Processing Plant is a versatile material that can be recovered readily from storage and treated to modify some of its properties if desired. Methods are discussed that were investigated, together with other methods that were considered but not yet tried, to modify the leachability, thermal conductivity, and physical dispersability of calcine. (auth)

264 (KFK-917) REMOVAL OF CONDENSED PHOSPHATES FROM RADIOACTIVE WASTES. Drobnik, S.; Kluger, W.; Hepp, H. (Kernforschungszentrum, Karlsruhe (West Germany)). Dec. 1968. 35p. (In German). Dep. CFSTI (U. S. Sales Only).

A method for the removal of condensed phosphates, which can interfere with the decontamination of radioactive wastes by chemical precipitation, was developed. The interferences occur first at a content of condensed phosphates of more than 25 mg P/l, so that in practice only special wastes, such as accumulate in the decontamination of work clothing and apparatus, must be treated. The checking of the radioactive wastes from similar institutes of the Kahlsruhe Nuclear Research Center over several weeks showed that only a very low total phosphate content was present in the normal wastes. Only the wastes from the washing and instrument decontamination provided an exception with values up to 80 mg P/l. In the studies it was established that all condensed phosphates with multivalent cations can be precipitated. With each cation, the maximum precipitation of the condensed phosphates occurs only in a given pH range. An additional condition for the precipitation is the presence of a sufficient quantity of cations. With an increase of the pH above the optimum value redissolution of the precipitate occurs. Only in precipitation with Ba^{2+} and Ca^{2+} ions

does dissolution of the precipitate not occur at high pH values. The Ba and Ca precipitates of the condensed phosphates are flocculent and deposit rapidly. Polyphosphates precipitate quantitatively; the necessary pH values increase with the chain length. The metaphosphates (ring phosphates) can also be precipitated with Ca^{2+} ions. Trimetaphosphate gives a precipitate with Ca^{2+} ions. With the precipitation method given some of the radionuclides were simultaneously removed from the wastes. (tr-auth)

265 (ORNL-4422) CHEMICAL TECHNOLOGY DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING MAY 31, 1969. (Oak Ridge National Lab., Tenn.). Oct. 1969. Contract W-7405-eng-26. 356p. Dep. CFSTI.

Separate abstracts were prepared for 21 sections of the report. Also included is a short summary of some special studies of nuclear-powered agro-industrial complexes. (M.C.G.)

For abstracts of individual sections see: 176–178, 213, 214, 266–273, 319, 342, 380, 415, 1067–1069, and 1110.

266 (ORNL-4422, pp 1-47) MOLTEN-SALT REACTOR PROCESSING. (Oak Ridge National Lab., Tenn.).

Research progress is reported under the following topics: molten-salt breeder reactor processing flowsheet analysis, distribution coefficients in molten salt–metal systems, solubilities of Th and Pa in Bi, metal transfer process for rare earth–thorium separation, development of a molten salt–bismuth electrolytic cell, reductive extraction engineering studies, simulated molten salt–liquid bismuth contactor studies, corrosion control by use of a frozen layer of salt, MSRE fuel salt processing, preparation of ^{233}U fuel for the MSRE, and distillation of MSRE fuel carrier salt. (M.C.G.)

267 (ORNL-4422, pp 48-106) DEVELOPMENT OF AQUEOUS PROCESSES FOR FAST REACTOR FUELS. (Oak Ridge National Lab., Tenn.).

Progress is reported under the following headings: shipping and receiving, head-end processing, removal of volatile fission products, dissolution and feed preparation, solvent extraction with TBP, extraction of plutonium with amines, removal of iodine from off-gas, radiation and shielding studies, and criticality studies. (M.C.G.)

268 (ORNL-4422, pp 107-19) DEVELOPMENT OF METHODS FOR PROCESSING HTGR FUELS. (Oak Ridge National Lab., Tenn.).

Research progress is reported on head-end burn-leach methods for processing HTGR fuel and mechanical head-end methods for processing of the fuel. Tests were carried out with hot-pressed compacts of the Dragon fuel. (M.C.G.)

269 (ORNL-4422, pp 120-53) WASTE TREATMENT AND DISPOSAL. (Oak Ridge National Lab., Tenn.).

Engineering, economic, and safety evaluations are being made of waste treatment and disposal processes. Wastes expected from the reprocessing of power reactor fuels are being characterized. Studies are being made on the separation of radioactive xenon and krypton from other gases by using permselective membranes. (M.C.G.)

270 (ORNL-4422, pp 252-71) SEPARATIONS CHEMISTRY RESEARCH. (Oak Ridge National Lab., Tenn.).

Research progress is reported on: extraction of metal sulfates and nitrates by amines, new separations agents, beryllium purification by solvent extraction, recovery of uranium from commercial phosphoric acid, rapid high-resolution chromatography, actinide and lanthanide intragroup separations by displacement elution from ion exchange resins, separations by precipitation, equilibria and mechanisms of extraction, relative potentials of the Bk(IV)/Bk(III) and Ce(IV)/Ce(III) couples, kinetics of metal ion extractions by organophosphorus acids, and aggregation and activity coefficients in solvent phases. (M.C.G.)

271 (ORNL-4422, pp 276-99) BIOCHEMICAL SEPARATIONS. (Oak Ridge National Lab., Tenn.).

Research on macromolecular separation is reported under the following headings: development of reversed-phase chromatography systems for separating transfer ribonucleic acids, engineering scaleup of biological macromolecular separations techniques, separation of transfer ribonucleic acids from B. subtilis A-12, separation of aminoacyl-RNA synthetases, and separation of ribosomal ribonucleic acids. Body fluid analysis is discussed under the following headings: prototype analyzers, separation systems, system components, identification of body fluid constituents, analytical results, data acquisition and analysis, and a literature survey. (M.C.G.)

272 (ORNL-4422, pp 306-11) REACTOR EVALUATION STUDIES. (Oak Ridge National Lab., Tenn.).

Linear programming models are being developed for use in the planning of optimal nuclear power systems in the United States. Fuel cycle costs are being evaluated for metallic uranium-fueled pressurized-water reactors, estimations are being made of costs for on-site vs. off-site fuel cycle facilities and shipping associated with liquid-metal-cooled fast breeder reactors, and studies carried out to develop a dynamic programming model for optimization of nuclear power systems. (M.C.G.)

273 (ORNL-4422, pp 329-32) CHEMICAL ENGINEERING RESEARCH. (Oak Ridge National Lab., Tenn.).

A stacked-clone contactor containing nine clones per stage and having reduced physical size and stage holdup was constructed, and initial evaluation tests were made. A new type of contactor, a pulsed stacked-clone contactor, is being developed; a first model was built and tested. A model small enough to fit in a glove box is now being designed. Conceptual designs of scaled-up contactors indicate that machines with 300 clones per stage, and possibly more, can be designed and built. (auth)

274 (ORNL-4437, pp 40-7) ISOTOPE CHEMISTRY. (Oak Ridge National Lab., Tenn.).

Developments are reported for studies on: fractionation of carbon isotopes–the COCO system; fractionation of carbon isotopes–the CYANEX system; chemical fractionation of uranium isotopes; mass spectrometric determination of small differences in deuterium concentration in water samples; molecular spectroscopy; and spectra of MoF_5. (P.C.H.)

275 ELUTION OF HEAVIER RARE EARTHS WITH H.E.D.T.A. ELUANT AT A HIGH TEMPERATURE. Hagiwara, Zenzi (Tohoku Univ., Sendai). J. Inorg. Nucl. Chem., 31: 2933-49 (Sept. 1969).

In order to study the detailed behavior in the separation of heavier rare earths by ion exchange with fairly high concentrations of HEDTA, the elutions were performed at 60°C under steady state conditions. The theoretical plate height in regard to the column efficiency was also investigated from the viewpoints of countercurrent extraction and rate theory, and the various experimental results relating to the mixed region of the adjacent rare earths were explained from the relation deduced. Also, under different experimental conditions, the contamination of thorium, present in a trace quantity in the heavier rare earth samples, was investigated at 60°C. The small peak of thorium moved to the lutetium side with increase in the concentration of HEDTA eluant. (auth) (UK)

276 NEW TECHNIQUES IN THE EXPLOITATION OF MINERAL DEPOSITS AND THEIR APPLICATION TO URANIUM. Martinez, Agustin Martinez (Junta de Energia Nuclear, Madrid). Energ. Nucl. (Madrid), 13: 4-9 (Jan.-Feb. 1969). (In Spanish).

New techniques for making low-grade mineral deposits economically exploitable are surveyed. These comprise unconventional mechanization and automation systems for handling large amounts of material. Chemical methods extract minerals in situ by employing dilute H_2SO_4 or HNO_3 through the use of pipes that lead directly into the deposits and make pumping of the solute possible. Autotrophic S- and Fe-bacteria are used to convert some ores into a more soluble form. In the USA and the USSR marginal and low-content U deposits can now be economically extracted using lixiviation by dilute H_2SO_4, $NaClO_3$, and flocculants. After 48 hours the U recovery is almost complete and consists of an aqueous extract containing 0.10 to 0.30 g/l U_3O_8. In the USA and the USSR nuclear explosions are used for the fracture of the mineral bed and subsequent extraction. Such explosions are also used in the USA, under guidance of the AEC, to make mineral oil and gas and solid minerals, such as low-grade Cu ore economically available. (F.J.W.)

277 SEQUENTIAL SEPARATION OF ^{35}S SPECIES FROM NEUTRON-ACTIVATED POTASSIUM CHLORIDE. Abdel-Rassoul, A. A.; Abdel-Aziz, A.; Aly, H. F. (United Arab Republic Atomic Energy Establishment, Cairo). J. Inorg. Nucl. Chem., 31: 3043-7 (Oct. 1969).

A method was developed for successive separation of some sulfur anions including sulphide, sulphite, sulphate, and thiosulphate by anion exchange chromatography. Potassium chloride proved adequate for their mutual separation. The distribution behavior of the ions was studied on different forms of the exchanger (nitrate or chloride), and with a number of eluting agents. The results are explained in the light of hydration and solvation of the ions under different conditions. The reversed order of selectivity encountered with increased electrolyte concentration in the mobile phase is also discussed. (auth) (UK)

278 EXTRACTION AND COMPLEXING OF CALIFORNIUM WITH 8-HYDROXYQUINOLINE AND 5,7-DICHLORO-8-HYDROXYQUINOLINE. Feinauer, D.; Keller, C. (Kernforschungs-

zentrum, Karlsruhe, Ger.). Inorg. Nucl. Chem. Lett., 5: 625-30 (Aug. 1969).

^{253}Cf, free from other alpha emitters, was used in the perchlorate for and extracted as described previously. With 5,7-dichloro-8-hydroxyquinoline (HDCO), the chelate $Cf(DCO)_3$ was extracted, similarly to Am. Extraction and stability constants were calculated, showing that the Cf complex is more stable in accordance with Dyrssen's rule. With 8-hydroxyquinoline (HOX) itself, hydrolysis occurs, leading to $Cf(OX)(OH)_2$; the hydrolysis of the smaller Cf ion is greater than that of Am and Cm, which form $M(OX)_3OH$. (UK)

279 THE SEPARATION OF THORIUM AND URANIUM(VI) ON RESIN SDV-3. Zhukov, A. I.; Kazantsev, E. I.; Zhitenev, V. A. (Ural Polytechnic Inst., Sverdlovsk, USSR). Zh. Prikl. Khim., 42: 1699-1704(Aug. 1969). (In Russian).

The separation of uranium and thorium on resin SDV-3 was studied. The advantages in comparison with KU-2 and KU-1 resins are a higher exchange capacity, greater swelling and smaller bond strength with the uranium ions at room temperature and at 90°C. The sorption of thorium by the resin and the subsequent elution of uranium make possible the separation of the two elements. (tr-auth)

280 SEPARATION OF METAL IONS ON TITANIUM(IV) TUNGSTATE PAPERS. Qureshi, Mohsin; Husain, Waqif (Aligarh Muslim Univ., India). Separ. Sci., 4: 197-207(June 1969).

Papers impregnated with titanic tungstate were used to chromatograph 52 cations in 45 aqueous and mixed solvents. Experimentally, a large number of complex cation separations were achieved easily and rapidly — Au^{3+}, Tl^{3+}, Ag^{+}, Mo^{6+}, K^{+}, Rb^{+}, Cs^{+}, Ni^{2+}, Sb^{3+}, Bi^{3+}, Be^{2+}, and Tl^{+} can be easily separated from numerous metal ions. Several quaternary, ternary, and binary separations were also achieved, and some important separations are discussed. (auth)

281 AMINO ACIDS AS RETAINING AGENTS IN DISPLACEMENT CHROMATOGRAPHY OF THE RARE-EARTH ELEMENTS. Winget, J. O.; Lindstrom, R. E. (Bureau of Mines, Reno, Nev.). Separ. Sci., 4: 209-16(June 1969).

The feasibility of using amino acids as retaining agents with ethylenediaminetetraacetic acid (EDTA) eluents in displacement chromatography of the rare earth elements was studied at 85° to 90°C. Hydroxyethylethylenediaminetriacetic acid (HEDTA) and diethylenetriaminepentaacetic acid (DTPA) were the most effective retaining agents investigated. Elements of atomic numbers 39 and 57 through 68 were effectively retained, whereas elements of atomic numbers 69 through 71 passed through the retaining-agent band. Utilization of HEDTA or DTPA as retaining agents permits the use of 7 to 10 g/liter EDTA eluting solutions, whereas eluting solution concentrations in the 4 to 4.5 g/liter range are maximum when using hydrogen or copper as retaining agents. Eighty-five per cent recovery of the EDTA eluent collected before rare-earth breakthrough and during elution of lutetium, ytterbium, and thulium, and essentially complete recovery of the HEDTA or DTPA retaining agents, are possible without extensive processing. (auth)

282 SEPARATION OF $NbCl_5$–$NbOCl_3$ MIXTURES BY CHEMICAL METHODS. MacCordick, John (Univ., Strasbourg). Separ. Sci., 4: 191-6(June 1969). (In French).

A laboratory procedure is described for the separation and recovery of the constituents in $NbCl_5$–$NbOCl_3$ mixtures. The method outlined is based on the difference in solubility in liquid nitrosyl chloride of the addition compounds formed by niobium(V) chloride and oxychloride with NOCl. Following isolation of the nitrosyl complexes, thermal decomposition leads to regeneration of the original chlorides. The procedure can be conveniently applied to several grams of mixture in any proportion and permits recovery in nearly quantitative yield. (auth)

283 SEPARATION OF PLATINUM METALS BY PAPER ELECTROPHORESIS. Singh, Rama S.; Tripathi, Satyendra N.; Ghose, Animesh K.; Dey, Arun K. (Univ. of Allahabad, India). Separ. Sci., 4: 171-9(June 1969).

Ruthenium, rhodium, palladium, osmium, iridium, and platinum were separated from a single spot in horizontal paper electrophoresis using ethylenediaminetetraacetic acid (EDTA) as background electrolyte. Electrograms were run using 0.01 M electrolyte, at pH 9.0, 10.5, 11.0, and 12.0. Binary, ternary, quaternary, and quinary separations are possible at various pH values, but best separation occurs at pH 11.0. At this pH, ruthenium and osmium slightly overlap with each other and can be separated by cutting this zone and placing it on a fresh paper and carrying on the electrophoresis, now using 0.1 M EDTA at pH 6.0. Ruthenium and osmium can thus be separated from each other on the second paper. The temperature is kept at 20°C, a potential 250 V is supplied, and the developing time is 3.5 hr. (auth)

284 EQUILIBRIUM CONSTANT FOR THE FRACTIONATION OF DEUTERIUM BETWEEN ICE AND WATER. Arnason, Bragi (Univ. of Iceland, Reykjavik). J. Phys. Chem., 73: 3491-4(Oct, 1969).

Results are reported for 24 experiments from which the equilibrium constant for the fractionation of deuterium between ice and water was determined. The fractionation constant obtained was $\alpha = 1.0208 \pm 0.0007$. (D.H.M.)

285 APPLICATION OF FILTERS FOR THE PURIFICATION OF SECONDARY STEAM, FORMED ON EVAPORATION OF RADIOACTIVE WASTE WATER. Shvedov, V. P.; Strizhov, S. G. Radiokhimiya, 11: 364-6(1969). (In Russian).

The efficiency of various filters for the purification of secondary steam, formed by evaporation of radioactive waste solutions, was investigated. The filters with the highest efficiency were silica gel KCC No. 4. A relation between the coefficient of purification and the volume of steam was developed. (M.C.G.)

286 EXTRACTION OF TRANSPLUTONIUM ELEMENTS BY FATTY ACIDS. Bochkarev, V. A. Radiokhimiya, 11: 341-4 (1969). (In Russian).

Optimum conditions for the extraction of transplutonium elements by fatty acids were investigated. Methods developed for curium and californium can be used for the isolation of transplutonium elements from solutions that contain significant quantities of Al, Fe, Ti, and other elements. (tr-auth)

287 SEPARATION OF SCANDIUM, TITANIUM, AND VANADIUM BY COPRECIPITATION WITH HYDROXIDES OF IRON AND ZIRCONIUM. Novikov, A. I.; Ruzankin, V. I.; Dedova, V. F. Radiokhimiya, 11: 347-50(1969). (In Russian).

The coprecipitation of small quantities of Sc, Ti, and V with iron hydroxide from a 1M solution of potassium nitrate on heating and stirring was studied. The coprecipitation of small amounts of Sc and Ti with iron hydroxide was also studied in a 5M solution of ammonium nitrate in the pH range 0.5 to 14.0. The coprecipitation of vanadium with zirconium hydroxide from solutions of 1M potassium nitrate was investigated. A method is proposed for the successive separation of scandium, titanium, and vanadium by coprecipitation of scandium and titanium with iron hydroxide at pH > 13.8 and by coprecipitation of titanium with the same carrier from a heated solution of potassium nitrate at pH = 2 to 2.8. (tr-auth)

288 STUDY OF CONDITIONS FOR AMALGAM FORMATION OF RARE EARTH ELEMENTS ON ELECTROLYSIS OF AQUEOUS ACETATE–TARTRATE ELECTROLYTES. Antonov, P. G.; Shvedov, V. P. Radiokhimiya, 11: 307-11(1969). (In Russian).

Optimum conditions were found for amalgam formation by lanthanides in acetate–tartrate media. It was established that the rate of reduction of rare earth elements on the mercury cathode from acetate–tartrate electrolytes is twice the rate of electrolysis from acetate–citrate electrolytes. Erbium, thulium, lutetium, and yttrium are not reduced in this medium. The yield of rare earth elements in the mercury phase, with the exception of europium, yttrium, and samarium, depends on the concentration of lithium tartrate. The effect of complexant concentration increased in proportion to the increase in the ordinal number of the lanthanides. (tr-auth)

289 SEPARATION OF RARE EARTH ELEMENTS OF THE YTTRIUM SUBGROUP BY ELECTROLYSIS USING A MERCURY CATHODE IN AN ACETATE–TARTRATE MEDIUM. Antonov, P. G.; Shvedov, V. P. Radiokhimiya, 11: 311-17(1969). (In Russian).

Optimum conditions for amalgam formation of gadolinium and terbium in acetate–tartrate media were found for the efficient separation of these elements from other lanthanides. The following values were determined for the coefficients of separation of binary mixtures of rare earth elements: Tb–Dy = 5–20, Tb–Ho = 15–30, Tb–Ho = 40–300 (greater electrolyzer) and Tb–Er = 40–80. The possibility of quantitative separation of gadolinium and terbium from traces of erbium, thulium, lutetium, and yttrium is shown. (tr-auth)

290 EXTRACTION OF URANIUM(VI) FROM AQUEOUS NITRATE SOLUTIONS BY A MIXTURE OF DIHEPTYLPHOSPHINIC ACID WITH TRIBUTYL PHOSPHATE IN TOLUENE. Vdovenko, V. M.; Vavilov, N. G. Radiokhimiya, 11: 279-86(1969). (In Russian).

The extraction of uranium(VI) by a mixture of diheptylphosphinic acid (DHPA) with TBP from nitrate solutions was studied. A synergistic effect was observed in the whole range of saturations of the mixture by uranium; the maximum magnitude of this

effect corresponds to the extraction of uranium from aqueous solutions at a molar ratio of organic solvent to uranium of 2 to 1. It was concluded that the synergistic effect results from the formation of a complex of the general type $[UO_2(NO_3)X] \cdot n(DHPA) \cdot m(TBP)$. (tr-auth)

291 EXTRACTION OF URANIUM(VI) FROM AQUEOUS NITRATE SOLUTIONS BY DIHEPTYLPHOSPHINIC ACID IN TOLUENE. Vdovenko, V. M.; Vavilov, N. G. Radiokhimiya, 11: 286-90(1969). (In Russian).

The extraction of uranium(VI) by toluene solutions of diheptylphosphinic acid from aqueous solutions that contain 0.01 to 1.0M nitric acid was studied. In aqueous solutions with pH < 1.5, uranium is extracted simultaneously by two mechanisms: cation exchange and solvation. (tr-auth)

292 DETERMINATION OF THE DISTRIBUTION COEFFICIENTS OF THE ELEMENTS OF THE IB, VB, VIA, AND VIB GROUPS IN ANIONIC ION EXCHANGE RESIN IN THE WATER–HYDROCHLORIC ACID–ACETONE MIXTURE. Cleyrergue, Ch.; Deschamps, N.; Albert, Ph. (CNRS-CECM, Vitry, France). pp 646-54 of Modern Trends in Activation Analysis. Vol. I. DeVoe, James R. (ed.). Washington, D. C., National Bureau of Standards, 1969.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md. See NBS-Spec. Publ.-312(Vol.1); CONF-681003-(Vol.1).

The variation of the distribution coefficients of As, Sb, Au, Ag, Cu, Se, Te, Mo, and W in Dowex-1 in a water–HCl–acetone mixture was studied as a function of % acetone in a 0.5N HCl solution. The results are presented graphically. The results suggest the separation of Fe from the elements of Group 1B, VB, VIA, and VIB. It is possible to apply this ion exchange method to the systematic radiochemical analysis of Fe and Ni and the method would lend itself to automatization. (B.L.M.)

293 EXTRACTION OF LANTHANIDES AND ACTINIDES BY ALKYLPHOSPHINE OXIDES. PART V. EXTRACTION OF TRIVALENT ACTINIDES BY SOME DIPHOSPHINE DIOXIDES. Goffart, J.; Duyckaerts, G. (Univ., Liege). Anal. Chim. Acta, 48: 99-106(Nov. 1969). (In French).

The distribution of trivalent actinides between an aqueous phase of constant ionic strength (2 M $NaNO_3$) and an organic solution of a diphosphine dioxide can be explained by the reaction: $Act^{3+}_{a} + 3\,NO^{-}_{3a} + x(1,n\text{-DiPO})_o \rightleftharpoons Act(NO_3)_3 \cdot x(1,n\text{-DiPO})_o$. The apparent stability constants were determined at 25° for some complexes: $Am(NO_3)_3 \cdot 2$ (1,4-DiPO): $(3.7 \pm 0.3)\ 10^6\ M^{-2}$; $Am(NO_3)_3 \cdot 2$ (1,5-DiPO): $(8.4 \pm 0.5)\ 10^5\ M^{-2}$; $Cm(NO_3)_3 \cdot 2$ (1,5-DiPO): $(5.6 \pm 0.4)\ 10^5\ M^{-2}$; $Cf(NO_3)_3 \cdot 2$ (1,5-DiPO): $(8.7 \pm 0.5)\ 10^5\ M^{-2}$; and $Am(NO_3)_3 \cdot$ (1,1-DiPO): $27 \pm 4\ M^{-1}$. (auth)

294 REPROCESSING FUEL ELEMENTS OF NATURAL URANIUM–GRAPHITE–CARBON DIOXIDE REACTORS OF THE EDF-2 TYPE. Israel, S.; Israel, M. Bull. Cent. Rech. Essais Chatou, No. 18, 73-87(Dec. 1966). (In French).

Problems associated with fuel renewal in a natural uranium–graphite–CO_2 reactor of the E.D.F. 2 type with the reactor in operation were evaluated, and a full computer program to establish the fuel movement schedule step-by-step was prepared. I.B.M. 7094 equipment was used. (auth)

295 USE OF ION-EXCHANGE TECHNIQUES FOR PRODUCTION OF HIGH-PURITY POTASSIUM FLUOTANTALATE. Bielecki, E. J. (Kawecki Chemical Co., Boyertown, Pa.). pp 776-88 of Advances in Extractive Metallurgy. London, Institution of Mining and Metallurgy, 1968.

From Symposium on Advances in Extractive Metallurgy, London, England. See CONF-670458.

Ion exchange techniques for separating tantalum and niobium were reviewed to establish a base for developing a potentially commercial process for their recovery from ores, concentrates, slags, residues, or dilute solutions from chemical processing. The anion exchange separation in fluoride media was investigated. Effects of resin crosslinkage and particle size were studied; and elution curves for niobium and tantalum were determined at various temperatures. By recycling the dilute eluates from the elution of niobium and tantalum to the succeeding cycle, use of fresh eluant solutions was minimized and concentrations of recovered elements were enhanced. Potassium fluorotantalate was prepared from the tantalum eluate by adding a soluble potassium salt. Niobium was recovered by precipitating the niobium eluate with ammonia. The resultant filtrate and wash were used to regenerate fresh niobium and tantalum eluants. (auth) (UK)

296 SEPARATION OF THE RARE EARTHS AND PRODUCTION OF THE METALS. Lever, F. M.; Payne, J. B. (Johnson, Matthey and Co., Ltd., Wembley, Eng.). pp 789-804 of Advances in Extractive Metallurgy. London, Institution of Mining and Metallurgy, 1968.

From Symposium on Advances in Extractive Metallurgy, London, England. See CONF-670458.

A brief review of mineral treatment and classical methods of separation for the rare earths is followed by a detailed description of the ion exchange separation process. The more important work on liquid–liquid extraction as a separation process is also mentioned, and an outline of the production of rare-earth metals is given. (auth) (UK)

297 PAPER CHROMATOGRAPHIC SEPARATION OF PLATINUM METALS WITH SPECIAL REFERENCE TO OSMIUM. PART I. ALCOHOLS, KETONES, AND ETHERS AS SOLVENTS. Meier, H.; Ruckdeschel, A.; Albrecht, W.; Boesche, D.; Hecker, W.; Menge, P.; Unger, E.; Zeitler, G.; Zimmerhackl, E. (Staatliches Forschungsinstitut fuer Geochemie, Bamberg, Ger.). J. Chromatogr., 44: 362-73 (Oct. 28, 1969). (In German).

The paper chromatographic behavior of osmium in known compounds was examined using alcohols, ethers, and ketones as solvents. The R_F values obtained when using different solvent mixtures were compared with those obtained for other platinum metals. A relationship was observed between the R_F values and the distribution coefficients α of the chloro- and bromo-osmium complexes. (auth)

298 PAPER CHROMATOGRAPHIC SEPARATION OF PLATINUM METALS WITH SPECIAL REFERENCE TO OSMIUM. PART II. MIXED SYSTEMS AND SALTS AS SOLVENTS. Meier, H.; Ruckdeschel, A.; Albrecht, W.; Boesche, D.; Hecker, W.; Menge, P.; Unger, E.; Zeitler, G.; Zimmerhackl, E. (Staatliches Forschungsinstitut fuer Geochemie, Bamberg, Ger.). J. Chromatogr., 44: 374-82(Oct. 28, 1969). (In German).

The paper chromatographic behavior of the platinum metals was examined by using various mixed systems, hydrochloric acid and solutions of inorganic salts as solvents. The gap in the paper chromatographic data concerning osmium was closed. A saturated sodium chloride solution proved to be specially suitable for the separation of platinum metals. The sequence of separation is: $Ir^{3+} = Rh > Ru > Pd > Pt > Os$. (auth)

299 THE EXTRACTION OF THORIUM(IV) FROM HYDROCHLORIC ACID SOLUTIONS BY TRI-n-OCTYLPHOSPHINE OXIDE. Sato, Taichi; Yamatake, Masahiro (Shizuoka Univ., Hamamatsu, Japan). J. Inorg. Nucl. Chem., 31: 3633-42(Nov. 1969).

The partition of thorium(IV) between hydrochloric acid solutions and kerosene solutions of trioctyl phosphine oxide (TOPO) was investigated. The organic phases were examined by ir and high resolution nuclear magnetic resonance spectroscopy. The mechanism of thorium extraction is discussed on the basis of the results obtained. (auth) (UK)

300 BITUMEN FIXATION OF SLUDGES FROM TREATMENT OF RADIOACTIVE EFFLUENTS. Fernandez, N. (Traitement des Effluents du Centre, Marcoule, France). Energ. Nucl. (Paris), 11: 357-65(Aug.-Sept. 1969). (In French).

The liquid effluent processing station at the Marcoule Center was equipped, May 24, 1966, with a plant for the bitumen fixation of inorganic sludges from previous decontamination treatments. A so-called "effluence" process was developed; this involves creating an unstable emulsion of sludges and bitumen and then mechanically extracting 90% of the water present, thus avoiding a difficult distillation operation. Its application in a continuous industrial process was achieved by means of original double-screw machines, great care having been brought to the choice of associated equipment. The results were completely satisfactory: sludges of all kinds were successfully treated and the bituminous products were of excellent quality; the volume of the wastes was reduced by about 25%; and the wastes can be stored with considerably improved safety. (auth)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 138, 140, 142–145, 147, 148, 151, 153, 300, 319, 322, 326, and 332.

301 CONTRIBUTION OF RADIOACTIVE TRACERS TO THE DETERMINATION OF DISCHARGES OF WATERCOURSES AND POLLUTED EFFLUENTS. Molinari, Jacques (CEN, Grenoble, France). Tech. Sci. Munic., 63: 133-46(Apr. 1968). (In French).

Measurement of pollution flux and of discharges may be studied by tracer techniques; new applications of ^{3}H, ^{51}Cr, ^{82}Br, ^{131}I, ^{198}Au, $^{113}Sn-^{113m}In$, and $^{137}Cs-^{137m}Ba$ are noted. Measurement of discharge by dilution of tracers permits resolution in the majority of cases in which classical hydrometry fails, regardless of the level of pollution. The use of γ emitters in the method of constant-discharge injection allows observation of concentration fluctuations when the discharge varies. A number of exact discharge values may be obtained to furnish a calibration curve for a station; with a combination of certain hydraulic conditions, a recording furnishes the real instantaneous discharge at once and permits evaluation of the exact mean flux of effluent pollution. Studies reported were carried out with ^{82}Br. (BBB)

302 CONCENTRATION CHANGES OF THORIUM, URANIUM, AND OTHER METALS IN HYDROTHERMALLY ALTERED CONWAY GRANITE: NEW HAMPSHIRE. Brimhall, Willis H.; Adams, John A. S. (Rice Univ., Houston, Tex.). Geochim. Cosmochim. Acta, 33: 1308-11(Oct. 1969).

Concentrations of Th, U, K, Mg, Ca, Mn, Fe, Zn, Co, and Cu are significantly different in two sections of a 1000 ft core sample of Conway granite. The differences, attributable to the action of weak hydrothermal fluids, indicate that the fluids, though weak, caused effective redistribution of these elements. (auth) (UK)

303 COMPARATIVE U–Th–Pb SYSTEMATICS IN 2.7 x 10^{9} YR PLUTONS OF DIFFERENT GEOLOGIC HISTORIES. Steiger, R. H.; Wasserburg, G. J. (California Inst. of Tech., Pasadena). Geochim. Cosmochim. Acta, 33: 1213-32(Oct. 1969).

A comparative study was made of the Pb–U–Th systematics on cogenetic zircons from three plutons with different geological histories but the same age (2.69×10^{9} yr). The first of these is in the Superior Province, Canada and is believed to be a virginal body. Assuming an episodic model, a secondary age of $455 \pm {}^{305}_{105}$ Myr is inferred. The second body is from the Grenville front and is known to have suffered an episode at 920 Myr. However, a secondary age of 350 ± 50 Myr is inferred. A third body in the Wind River Mountains, Wyoming, has no known metamorphic history, but was uparched in Laramide time. A secondary age of $130 \pm {}^{60}_{100}$ Myr is inferred. It is concluded that unless independently documented, the secondary ages inferred by the episodic model are in general invalid. The zircon systematics appear to be dominated by the occurrence of highly discordant and almost concordant phases. The discordant phase responding to diffusion loss which may be in the "non linear" region is described. (auth) (UK)

304 URANIUM-RICH SEDIMENTS ON THE EAST PACIFIC RISE. Fisher, D. E.; Bostrom, K. (Univ. of Miami, Fla.). Nature (London), 224: 64-5(Oct. 4, 1969).

The results are reported of U analyses of a series of sediments taken during a traverse across the East Pacific Rise. Most samples were from the depth interval 30 to 70 cm in the sediment cores, except for a few localities from which surface material could be obtained. Measurements were made by fission track analysis on total sediment samples. The samples were covered with Lexan plastic and reactor irradiated, the U fissions induced providing energetic fragments that impinged on the plastic and left tracks visible after etching in NaOH. Results are tabulated and shown graphically, and indicate a higher than normal U concentration at the ridges. It is considered unlikely that the U is a biogenic constituent in the sediments; the close association between high heat flow, high U content and enrichment in the crest sediments of other probably volcanogenic constituents suggests a similar volcanic origin for U. (UK)

305 EFFECTIVENESS OF DETERMINATION OF THE POROSITY OF SANDY SHALY FORMATIONS FROM THE RESULTS OF GAMMA–GAMMA AND NEUTRON LOGGING IN COMBINATION WITH GAMMA AND SP LOGGING. Gulin, Yu. A. Neftegazov. Geol. Geofiz., No. 9, 23-8(1968). (In Russian).

It is shown that under favorable conditions gamma–gamma logs unambiguously reflect the porosity of sandy-shaly rocks, but results of determinations of porosity of sandy-shaly rocks from neutron logs are not reliable because of the effect of the clay content, and the effect is twice as great in calculating error of porosity determination in neutron–gamma logging than in neutron–neutron logging (for hydromica and kaolinitic clays). Therefore, it is possible to use neutron logs to determine the porosity of such rocks only if the clay content does not exceed 3–5 percent in neutron–gamma logging or 5 to 10 percent in neutron–neutron logging. In introducing a correction for the effect of clay content on the basis of gamma or SP logs, the accuracy of determination of porosity of shaly formations from neutron logs, when the effect of other disturbing factors is excluded, is ±2 to 3 percent of the volume of the rock, or ±15 to 25 percent of the determined value. Results of gamma and SP logging can be used in the conditions examined to estimate the porosity of sandy-shaly formations. (Geophys. Abstr.)

306 PROCEDURE OF REDUCING NEUTRON–GAMMA LOGGING DIAGRAMS TO UNIT CONDITIONS. Omes, S. P.; Mikhaylin, A. S. Razved. Geofiz., No. 26, 93-100(1968). (In Russian).

Quantitative interpretation of neutron–gamma logs is possible only when the readings are given in the same units, regardless of the conditions of measurement or construction of the apparatus. Therefore, the first stage in interpretation is reduction of the readings to the same unit conditions. The several ways of doing so are discussed and found to have certain deficiencies. A method is proposed which is suitable for small values of the differentiation coefficient and is free of the defects mentioned. It is based on the assumption that if there is a formula for converting to neutron–gamma readings in unit conditions for some category of formations (standard formations), then it is suitable for all other formations in a given well. Clays are chosen as standard formations as their mineralogical composition usually is less variable areally and the readings against clays are governed mainly by well diameter. Thus, in clastic formations with low differentiation coefficients it is easiest to reduce neutron–gamma readings to unit conditions using the curve of the dependence of the value of radiational gamma-radiation of clays on well diameter. This excludes the effect of source intensity and differences in the differentiation coefficient of the individual complexes of the apparatus. (Geophys. Abstr.)

307 MATHEMATICAL MODELING OF GAMMA-TRANSFER IN PROBLEMS OF THE THEORY OF SELECTIVE LOGGING. Marenkov, O. S. Izv. Akad. Nauk SSSR, Fiz. Zemli, No. 9, 107-11(1968). (In Russian).

The Monte Carlo method is considered as a way of solving problems of the theory of selective logging. The main advantage of the model of gamma transfer processes examined here is the possibility of obtaining high statistical accuracy of calculations with a comparatively small number of traced photon histories. The expenditure of machine time is determined by the number of discrete points for each of the parameters, ρ, x, and h. Analysis of numerical data on the distribution of the gamma field in ores of variable density shows that prospects are good for using the selective method at the stage of exploitational surveying of deposits of metals with medium atomic numbers; rapid analysis of samples and spalls of the rock mass; assaying the walls of mine workings, outcrops, and short underground drill holes; and logging dry holes. (Geophys. Abstr.)

308 KINETICS OF ADSORPTION OF ^{90}Sr ON THE BOTTOM OF CONFINED WATER BASINS. Prokhorov, V. M. Radiokhimiya, 11: 317-25(1969). (In Russian).

It is shown that the kinetics of adsorption of ^{90}Sr from water confined in a basin is determined (with the exception of a small initial period) by the actual rate of diffusion of ^{90}Sr in thick bottom deposits. Adsorptive equilibrium of ^{90}Sr between water and the bottom of the reservoir could not be proved. Formulas were developed that permit, without the utilization of empirical magnitudes, the forecasting of the concentration of ^{90}Sr in water and in the bottom deposits for any moment from known concentrations for other times. (tr-auth)

309 RADIOCARBON ISOCHRONES ON THE DISINTEGRATION OF THE LAURENTIDE ICE SHEET. Bryson, Reid A. (Univ. of Wisconsin, Madison); Wendland, Wayne M.; Ives, Jack D.; Andrews, John T. Arctic and Alpine Res. (Boulder, Colo.), 1: 1-14(Winter 1969).

Values of ^{14}C dating published from 1959 to 1968 were used to construct an isochrone map relating to the retreat of Wisconsin glaciation. The last great event of the Wisconsin Glacial Stage in

North America was the disintegration of the Laurentide Ice Sheet. This occurred between 13,000 and about 5000 yr ago and had a profound effect upon the paleogeography of the continent. Analysis of present-day distribution of fauna and flora, the archaeological record, and climatic and sea-level fluctuations are intimately bound up with ice sheet disappearance, yet there has been no systematic attempt to utilize existing radiocarbon and geological data to attempt a plot of the ice sheet perimeter at specific intervals through time. This was attempted in the form of 2 maps, the first being a portrayal of isolines drawn on the radiocarbon data, the second map is a subjective interpretation of the first based upon geologic field evidence. Some immediate implications raised by the maps are discussed and a series of conclusions derived. (BBB)

310 DETECTING GAS-BEARING FORMATIONS AND FLOODED ZONES FROM MEASUREMENTS BY TWO NEUTRON GAMMA LOGGING SONDES UNDER THE CONDITONS OF THE GAS-CONDENSATE DEPOSITS OF THE KRASNODAR TERRITORY. Omes, S. P.; Chuykov, A. F. Razved. Geofiz., No. 27, 72-85(1968). (In Russian).

As shown by investigations in the Leningrad field, neutron–gamma logging in its usual form does not distinguish between gas-bearing and water-bearing layers or detect flooded zones. The possibility of solving the problem by using two neutron–gamma sondes of different length has been investigated. The fundamentals of the method and the apparatus and measurement procedure are described. Results obtained on the gas condensate deposits of the Yeysk–Berezan region did distinguish layers with high gas saturation from water-bearing layers. With repeated measurements, it was possible to distinguish water-flooded gas-bearing formations and intercalations. The sign of a gas-bearing layer was a positive increment (readings of the large sonde exceeding those of the small one) higher than 0.4 arbitrary units. (Geophys. Abstr.)

311 GEOCHEMICAL BEHAVIOR OF ISOTOPES IN THE URANIUM AND THORIUM FAMILIES IN GROTTO CONCRETIONS: APPLICATION TO THE DATING OF STALAGMITES. Nguyen Huu Van; Lalou, Claude (CNRS, Gif-sur-Yvette, France. Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. D, 269: 560-3(Aug. 4, 1969). (In French).

It is shown that, as with the carbonates of marine origin, the decay products of ^{238}U are not in equilibrium in the grotto concretions and that these nonequilibrium conditions can be utilized for dating some concretions up to about 400,000 years, extending the method of dating by ^{14}C. (tr-auth)

312 RADIOACTIVITY OF THE ZIRCON AND XENOTIME CRYSTALS FROM THE ENDERBITO BETWEEN SALAZAR AND DONDO (ANGOLA). de Morais, Marilia Xavier. Publ. Museu Lab. Mineral. Geol. Univ. Coimbra Centro Estud. Geol., Mem. Notic., No. 61, 85-90(1966). (In Portuguese).

Using nuclear emulsions the radioactivity of the zircon and xenotime crystals was studied. The zircon crystals were the most frequent and some of them changed to malacon. All of the xenotime crystals from this rock were radioactive and in order to study them the absorption coefficient of the α particles relative to the air had to be determined. (auth)

313 USE OF THE PULSED NEUTRON–NEUTRON METHOD (INNM) IN MONITORING THE DEVELOPMENT OF OIL FIELDS. Koshlyak, V. A. Geol. Nefti Gava, No. 7, 46-9(1968). (In Russian).

An attempt to use pulsed neutron–neutron logging to monitor the development of oil fields in the coal-bearing beds of northwestern Bashkiria is described. In formations that have not been perforated, or perforated only in their top part, pulsed neutron–neutron investigations are 87 to 100 percent effective in determining the nature of flooding of the producing formations in wells during the course of development. In completely perforated formations the efficiency is only 70 percent, which is considerably better than on oil fields in Devonian clastic formations such as the Romashkino or Tuymazy; however, the efficiency can still be improved in this case by combining pulsed neutron–neutron logging with flowmeter and moisture-meter measurements. (Geophys. Abstr.)

314 NUCLEAR LOGGING. Itoh, Toshinobu (Japan Petroleum Development Co., Tokyo). Sekiyu To Sekiyu Kagaku, 13: No. 4, 86-90(Apr. 1969). (In Japanese).

Various logging methods using nuclear phenomena are discussed. In gamma logging, γ-radiation emitted from the bed is measured by a scintillation counter, and the material containing large amounts of ^{40}K and ^{228}Th is easily detected. Since the degree of γ Compton scattering is in proportion to the density, γ density logging makes continuous density measurement possible by the use of a γ radiation source, such as ^{137}Cs, and a γ detector. There are two methods of neutron logging: thermal neutron logging and epithermal neutron logging. In the former method, fast neutrons directed to the bed from a neutron source such as Ra–Be or Am–Be are slowed down in the bed. Thermal neutrons are detected with a BF_3 counter. In the latter method, epithermal neutrons can be detected with a ^3He counter. This method can avoid the effects of chlorine which has high thermal neutron absorption cross section. Neutron lifetime logging is based on the principle that attenuation of pulsed-neutrons is governed by composite elements of the bed and their contents. γ-radiation induced by nuclear reaction with neutrons is peculiar to reactant nuclides. On the basis of this principle, analysis of composite elements is possible. Radioactivated nuclides emit characteristic γ radiation during decay. By detecting this γ radiation, the composition of the bed can also be examined. (NSA of Japan)

315 RADIOCARBON DATING OF RECENT EVENTS. Tamers, M. A. (Instituto Venezolano de Investigaciones Cientificas, Caracas). Atompraxis, 15: 271-6(July-Aug. 1969).

The contamination of the dynamic carbon reservoirs of the earth's surface with nuclear weapon fallout radiocarbon can be used for the estimation of the ages of events that have taken place during the last years. The evolution of the excess activity in Venezuela is traced since 1957 with known age plant materials. Two examples of radiocarbon dating of recent events are given. It is shown that for individual samples from houses of the Warao Indians several possible ages are obtained from each measurement, but that others can be excluded by the radiocarbon concentrations. However, for the three year repeated measurements on a series of wells of the rapid flowing Barquisimeto ground water, i.e., sequential samples, the analysis of the entire data permits determinations of the exact ages of the samples. (auth)

316 DISTRIBUTION OF RADIUM-226 IN HOT SPRINGS, AND THE MECHANISMS OF FORMATION OF STRONGLY RADIOACTIVE SPRINGS. PART 3. Iwasaki, Iwaji (Tokyo Inst. of Tech.). Onsen Kogakkaishi, 6: 165-8(July 1969). (In Japanese).

The distribution of radium in hot springs in Japan is briefly reviewed. About 40% of the hot springs contain 0.1×10^{-12} to 1.0×10^{-12} g/l radium in comparison with ordinary waters. Radium content was viewed from the physical geography. In general, hot springs with high radium content originated in the acidic rock formations rich in SiO_2. The relation between radium content and spring temperature was not clarified but there are indications that significant factors other than the spring temperature are operative. Radium content should be high for springs with larger evaporation residual, however it was not necessarily the case. According to the survey, the radium content in Japanese springs was larger in the hot springs of weak acidity, neutrality, and weak alkalinity. The relationship of radium content with chemical composition is reviewed. (NSA of Japan)

317 THERMAL DISCHARGES REQUIRE ADVANCE PLANNING. Jaske, R. T. (Battelle Memorial Inst., Richland, Wash.). Ind. Water Eng., 6: 18-21(July 1969).

Battelle–Northwest studies of the impact of thermal discharges from nuclear and fossil-fueled power plants done for federal, public, and private agencies concerned with energy development are summarized. The tendency to aggregate nuclear capacity in superplants aggravates the general problem of heat dissipation because of the limitations on the local temperature rise imposed by State Standards under the Clean Water Restoration Act of 1966. Cooling towers increase operational costs by about 0.2 to 0.4 mill/kWhr. So the choice of plant size and cooling method should be carefully weighed in advance. The examination of an entire regional system is essential in station siting. This involves the integration of all proposed stations from the standpoint of thermal differential allowable at a given point. Using simulation, it is possible to create the entire future cooling environment for a given river system or subsystem. Where utilities with adjacent service areas compete for available cooling differential in a stream of limited capacity, it is possible to adjust locations with sufficient precision as to obviate the possibility of interference in the assignment of temperature effects. As an example of the possibilities which can be examined, the anticipated annual average effect of a series of existing and likely developments on the Illinois Waterway is summarized. Nuclear capacity at Dresden (270 miles from mouth of river) is scheduled to be increased by 1430 MW(e) between 1964 and 1970; in the same time period fossil-fuel generating capacity at Peoria (river mile 158) will increase by 281 MW(e). The effects of these plants in the year 1970 are outlined to define the extent to which the proposed plant loadings contribute to higher temperatures at various points along the Illinois Waterway. By superposition the contribution of all of the plants on the system can be identified by location and time. It was shown

that little or none of the thermal effect introduced at Dresden is felt below river mile 120. (BBB)

318 ISOTOPIC AGE DETERMINATIONS ON ECLOGITES: A POSSIBLE SOURCE OF ERROR. Spjeldnaes, Nils (Univ. of Aarhus, Denmark); Bryhni, Inge. Lithos, 2: 215-16(1969).

Errors in the radiopotassium/radioargon ratios, which result in abnormally high age values, in eclogites are considered in terms of the mode of their transition from basalt. The very high $^{40}K/^{40}Ar$ ages obtained from clinopyroxene have generally been disregarded because this mineral is likely to contain excess radiogenic Ar. The $^{40}K/^{40}Ar$ ages on secondary hornblende and phlogopite have, however, been accepted as minimum ages for eclogite crystallization. Possibly excess potassium is generally expelled during transformation of basaltic rock to eclogite. A mechanism of basalt-eclogite transformation making the rock system partly closed for Ar, but open for K, would produce eclogites with excess Ar. Different ease of accommodation of older radiogenic Ar in the various minerals would produce discordant isotopic ages. It is unlikely that ^{40}K and ^{40}Ar were removed in the same proportions from each mineral. Even small differences in the rate of escape would seriously alter the apparent age. Concentration of mica in the contact zone of some eclogite bodies indicates that potash expulsion really has taken place. (BBB)

Meteorology

Refer also to abstracts 139, 149, 152, and 339.

319 (ORNL-4422, pp 326-8) SITING OF FUEL REPROCESSING PLANTS AND WASTE MANAGEMENT FACILITIES. (Oak Ridge National Lab., Tenn.).

Studies were made of long-range considerations involved in the siting of commercial fuel reprocessing plants and waste management facilities. The need for standards or regulations, factors that influence the sizes of sites, the safety and economics of large fuel reprocessing sites, alternative schemes for the management of high-level wastes, the effects of shipping radioactive materials, and the question of whether reprocessing and waste facilities should be located on private lands are discussed. (M.C.G.)

320 MONITORING OF THE RADIOACTIVITY OF AIR AND WATER. Juguet, Bernard (Laboratoire d'Hygiene, Paris). Tech. Sci. Munic., 64: 123-30(Apr. 1969). (In French).

Radioactivity of the region about Paris from natural sources (^{40}K, Ra, cosmic radiation) is 0.7 disintegration/min mg. Methods used at this laboratory for atmospheric and surface water studies are outlined. Variations of Rn follow those of numerous constituents of the air through the day; after nuclear explosions in the atmosphere the mean β activity of fine particles rose from 0.02 to 10 pCi/m^3. Data compared with those obtained from Casaccia, Italy, showed similarities and could be traced to the same date of explosion. Mean values of surface water, 2 pCi/l, attained values above 20 pCi/l after tests. The source networks for the city, however, showed only a slight rise. A delay of 2 days between fallout and the elevation of surface water activity was observed, and another 2 days for the rise in distributed water. Correlations of ^{95}Zr activity in river mud with Chinese tests, ^{131}I in bovine thyroids, and radioisotopes of Fe and Mn in snail hepatopancreas were noted. Routine analysis of separate isotopes is needed, as well as freely exchanged data from global monitoring stations. (BBB)

321 INVESTIGATION OF THE TRANSPORT OF FALLOUT FROM THE SEVENTH CHINESE NUCLEAR EXPLOSION INTO THE ALPS. Sladkovic, R. (Physikalisch-Bioklimatische Forschungsstelle der Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung, Garmisch-Partenkirchen, Ger.). Arch. Meteorol., Geophys. Bioklimatol., Ser. A, 18: 87-110(1969). (In German).

The first swath of artificial radioactivity from the 7th Chinese nuclear explosion of December 24, 1967 was detected at the 3 mountain sites Zugspitze (2963 m), Wank (1780 m), and Garmisch-Partenkirchen (735 m) on the morning or afternoon of December 31, 1967. In Berlin it was not detected until January 5, 1968. The peak levels detected at Zugspitze and Garmisch-Partenkirchen were 1.31 and 1.79×10^{-12} $\mu Ci/cm^3$, respectively. The first fallout arrived at the Zugspitze station on the 7th day after the test, and 12 hr later at the valley station. This implies that conditions for fallout transport and downward tropopause penetration must have been exceptionally favorable in the region surrounding these stations. A meteorological study revealed that the radioactive material had been transported from the explosion site by a relatively strong jet stream. It was also found that the fission products were carried downward into the troposphere by high-level subsidence in the eastern Atlantic Ocean during the period December 29, 1967, 12 hr to December 30, 00 hr (CET). Isentropic trajectories were computed leading backward from the Zugspitze peak from December 31 to 29, 1967; it was found that the airflow originated in this subsidence region. Computations of potential vorticity demonstrated the stratospheric origin of the air mass marked by the fresh fallout. (BBB)

322 NUCLEAR RADIATION IN THE ENVIRONMENT: BETA AND GAMMA-RAY DOSE RATES AND AIR IONISATION FROM 1951 TO 1968. Gibson, J. A. B.; Richards, J. E.; Docherty, J. (Atomic Energy Research Establishment, Harwell, Eng.). J. Atmos. Terrest. Phys., 31: 1183-96(Sept. 1969).

The dose rate (and air ionization) due to beta and gamma radiation was measured continuously over open grassland at Grove, Berkshire, from 1961 to 1968. The measurements are compared to the dose rate calculated from the radioactivity deposited from nuclear weapon tests for the purpose of estimating the dose rates back to 1951. These data are required for estimating possible biological effects on man and for studies of the electrical potential gradient in the atmosphere. Dose rates from natural sources were also considered and calculations and measurement of the dose rates from cosmic rays, radioactivity in soil and in air are included. The results for gamma radiation from fallout (at 1 m) show a good correlation between measurement and calculation. The maximum dose rates occurred soon after the weapon tests of 1958, 1961, and 1962, with levels up to 3.6 $\mu rad\ hr^{-1}$ (in air) or 2.7 ion pairs $cm^{-3}\ sec^{-1}$ (I) (at 50 cm). The corresponding maximum levels for beta radiation (1 m) were 40 $\mu rad\ hr^{-1}$ (in air) or 36I (50 cm). These levels must be modified to allow for attenuation by clothing, etc., before they can be applied to man, but the ionization of the atmosphere can be related directly to the potential gradient. The corresponding natural levels are 3.4 $\mu rad\ hr^{-1}$ (2.2I) for cosmic rays, 3.7 $\mu rad\ hr^{-1}$ (2.4I) for gamma radiation from air and soil, 1.4 $\mu rad\ hr^{-1}$ (1.6I) for beta radiation and 1.4I for alpha radiation in air. The total natural ionization at Grove is 7.7I. These calculations may be applied to other locations by allowing for the differences in the radioactive content of the ground and air, barometric pressure (cosmic radiation), latitude (cosmic radiation and fallout), and rainfall (fallout). (auth) (UK)

323 RADIONUCLIDE CONCENTRATIONS IN SURFACE AIR: DIRECT RELATIONSHIP TO GLOBAL FALLOUT. Kleinman, Michael T.; Volchok, Herbert L. (Health and Safety Lab., New York). Science, 166: 376-7(Oct. 17, 1969).

By relating the average monthly hemispheric concentrations of radionuclides in the surface air to the monthly hemispheric fallout of these nuclides, proportionality constants were derived. For every disintegration per minute of a radioactive nuclide per 1000 cubic meters of the surface air in the Northern Hemisphere, 3.3 kilocuries of that nuclide will be deposited on the surface; in the Southern Hemisphere, 5.0 kilocuries will deposit for every disintegration per minute per 1000 cubic meters. On the basis of these factors, the global deposition of radionuclides can be estimated from a relatively small number of measurements of the radioactivity in the surface air. (auth)

324 TENTATIVE METHOD OF ANALYSIS FOR ^{222}Ra CONTENT OF THE ATMOSPHERE. Health Lab. Sci., 6: 114-29(Apr. 1969).

A summary of the techniques presently used for measurement of airborne radon is presented in this paper. These methods are useful in determining the potential hazard of radon in certain occupational environments, in evaluating the radiation hazard of ambient radon to population groups, and in atmospheric tracer studies involving radon. (auth)

325 STUDY OF RADIOACTIVE CONTAMINATION OF THE BIOSPHERE WITH A PARTICULAR EMPHASIS ON INFLUENCE OF DIETARY COMPOSITION UPON THE RADIOACTIVE MATERIAL INTAKE INTO ORGANISM. Popovic, V. Arh. Hig. Rada Toksikol., 19: Suppl. 1, 85-97(1968).

Increases and decreases of the biospheric radioactive contamination following nuclear explosions in the period from 1960 to 1966 are presented. The effect of dietary composition upon the intake of ^{90}Sr in the organism was investigated. Research conducted to study the factors affecting the environmental contamination, and to develop more effective methods of experimental work is described. (auth)

326 RADIOACTIVITY: BURDEN FROM A BOON. Strauss, Sheldon D. Power, 113: No. 10, 66-9(Oct. 1969).

The adequacy of present AEC health and safety standards on the release of radioactive gases and liquids from nuclear power plants is questioned. The standards are discussed briefly. To date environmental contamination from nuclear stations has been well below safety hazard levels, but whether even this low level of contamination is permissible is pondered. (L.C.L.)

Mineralogy and Exploration

Refer also to abstract 276.

327 (NIM-414) GEOCHEMISTRY OF SOME URANIUM MINERALS IN THE DOMINION REEF AND WITWATERSRAND SYSTEMS. Mihalik, P. (National Inst. for Metallurgy, Johannesburg (South Africa)). Oct. 15, 1968. 38p. Dep. CFSTI (U. S. Sales Only).

The electron-microprobe investigation of a number of uranium-bearing minerals present in the Dominion Reef and Witwatersrand Systems is described. Among those that are expected to be refractory are a uranium-bearing zircon and a uranium-bearing chromite. The occurrence of a uraninite with an unusually high lead content is also described, but it is not known whether it is refractory or not. The occurrence of an eschynite-like mineral forming a thick coating on uraninite grains is also described. (auth)

328 (NIM-415) URANIUM COMPOUNDS IN THE DOMINION REEFS, AND THEIR ASSOCIATION WITH PHOSPHOROUS COMPOUNDS. Mihalik, P. (National Inst. for Metallurgy, Johannesburg (South Africa)). Nov. 6, 1968. 19p. Dep. CFSTI (U. S. Sales Only).

Nine samples of uranium ore from the Bramley Shaft of the Dominion Reefs Mine were investigated mineralogically and with the electron microprobe to find the cause of the poor leaching characteristics of a fraction of the uranium minerals. The investigation, which is at present still in its preliminary stage, has shown that, in samples that exhibit good leaching characteristics, uranium is generally not intimately associated with phosphorous compounds, whereas the converse is generally true of samples having poor leaching characteristics. The existence of a number of hitherto unknown uranium minerals is also indicated, and it is suggested that they may contribute to the refractory nature of some of these uranium ores. (auth)

329 THORIUM AND URANIUM IN DETRITAL MONAZITE FROM THE GEORGIA PIEDMONT. Overstreet, William C.; Warr, Jesse J. Jr.; White, Amos M. (Geological Survey, Washington, D. C.). Southeast. Geol., 10: 63-76(Apr. 1969).

Fifteen samples of detrital monazite from the Georgia Piedmont contained 3.3 to 6.1% ThO_2 and 0.13 to 0.67% U_3O_8, in accord with a previously established correlation of increased Th content in monazite as the metamorphic grade of the host rock increases. The decrease in percentage of Th in monazite southwestward from the center of monazite mining in the Carolinas is paralleled by a decrease in regional metamorphic grade of gneiss and schist that underlie the monazite-bearing streams and are partly the source of the monazite. At the border between North and South Carolina the placers are found over schist and gneiss of the sillimanite–almandine subfacies and over syntectonic quartz monzonite. In the Oconee County area rocks of sillimanite-almandine subfacies are present but they are scarce; the dominant rocks are at the staurolite-kyanite subfacies. Farther southwestward in Georgia along the monazite belt the sillimanitic rocks tend to disappear, and rocks of the staurolite-kyanite subfacies and of lower metamorphic facies are present. Relations and geologic controls of the amount of U in monazite remain unclear; possibly low U/Th ratios associated with high percentages of Th indicate a granitic source, and high ratios associated with low percentages of Th indicate paraschist or paragneiss as the source. Further work on this problem is needed. Monazite with commercially acceptable tenors in Th is present locally in Georgia, but it is more restricted in areal extent than it is in the Carolinas where alluvial placers were formerly mined for monazite. (BBB)

330 URANIUM IN THE TERTIARY INTERMONTANE BASINS OF COLORADO. Malan, Roger C. (Atomic Energy Commission, Grand Junction, Colo.). Mt. Geol., 6: 41-5(Jan. 1969).

The major stratiform U deposits in sedimentary rocks in the Tertiary basins of Wyoming which are discussed account for ~¼ of the total U reserves plus production in the western United States. The source of the U is also considered. Most of the established U resource in the Colorado Rockies is in Tertiary vein deposits. These vein deposits, including those in the Front Range, in the Cochetopa district near Gunnison, and at Marshall Pass in the Sawatch Range are spatially and probably genetically related to plutonic sources of early and middle Tertiary metallization in the Colorado mineral belt. The distribution of stratiform U deposits in Tertiary sediments in Colorado is spatially unrelated to the mineral belt. However, these deposits are closely related to upper Eocene to lower Miocene volcanic fields where lithologically favorable, fluvial host sediments are subjacent to the volcanic piles in upland basins or subjacent to tuffaceous lake beds and fluvial volcaniclastic outwash in deeper basins. The erosion of Precambrian granitic terrain in surrounding highlands often provided either part or all of the clastic material in the fluvial host rocks. The high fluid transmissibility of such sediments probably was an important control on the circulation of mineralizing meteoric waters. Some of the granites in the Front Range are highly enriched in Th and moderately enriched in U, but the U content of the Tertiary silicic pyroclastic volcanics is not established. The availability of trace amounts of U through solution in migrating meteoric waters appears to be much greater in the pyroclastic rocks than in the granitic rocks or in arkose derived from the granites. The amount of U in present-day ground and surface waters draining tuffaceous sedimentary environments is nearly 8 times greater than the amount of U in waters draining granitic or arkosic environments in Colorado and Wyoming. Trace amounts of U in both the granite and the pyroclastic volcanics may be sources for the concentrations of U in the Tertiary basins of Colorado, but the pyroclastics probably are the more important contributors. Since these Tertiary pyroclastics originated through syntexis in Precambrian rocks, the original source of the U they contain was in the basement. The U. S. Atomic Energy Commission is currently analyzing the distribution of U and Th in the various age groups and facies of the Precambrian throughout the western United States. (BBB)

331 THE PROBLEM OF COFFINITE (URANIUM SILICATE MINERAL). Belova, L. N.; Tananaeva, G. A.; Frolova, K. E. At. Energ. (USSR), 27: 61-3(July 1969). (In Russian).

In nature coffinite is usually contaminated by clay or silicate minerals such as hallyasite, montmorillonite, kaolin, chlorite, and pyrites. A sample of coffinite from a granite-porphyry mass was analyzed. Replica analysis by electron microscope showed the presence of hallyasite in the coffinite. The chemical analysis showed that coffinite is a mixture of U(IV) and U(VI) silicates in which the SiO_4 group is not replaced by the $(OH)_4$ group. Infrared spectroscopy also showed the absence of hydroxyl groups in coffinite. These results show that the coffinite sample is devoid of indications of metamictization. Water found in coffinite is associated with its hydration in the process of metamictization, as is also often observed in other minerals. (TTT)

Oceanography

Refer also to abstracts 109, 111, and 146.

332 NATURAL THERMOLUMINESCENT DOSIMETRY IN LATE PLEISTOCENE PELAGIC SEDIMENTS. Bothner, Michael H.; Johnson, Noye M. (Dartmouth Coll., Hanover, N. H.). J. Geophys. Res., 74: 5331-8(Oct. 15, 1969).

The natural thermoluminescence and associated radioactivities of four previously dated deep-sea cores were examined for their compatibility as a radiation dosimetry system. The radiation dose equivalence of the natural thermoluminescence in foraminiferal ooze is observed to build up systematically with increasing age. By 10^5 to 10^6 years, however, the dosimetry system in most calcareous ooze is effectively saturated. This pattern of dose build-up and saturation with time is consistent with certain general theoretical considerations. It appears, therefore, that the indigenous radiation dosimetry system of foraminiferal ooze, represented by its intrinsic thermoluminescence, is operating in a rational and predictable fashion and will provide reliable dosimetry data. (auth)

333 OCEANIC CONCENTRATIONS OF ^{228}Ra. Moore, Willard S. (State Univ. of New York, Stony Brook). Earth Planet. Sci. Lett., 6: 437-46(Sept. 1969).

Worldwide oceanic distribution of ^{228}Ra was evaluated. Nearshore waters, especially waters from restricted bays and sounds, were very high in unsupported ^{228}Ra. The concentrations decreased away from land. The ^{228}Ra content of surface waters bears a close correlation with the proximity to land. Samples from the Atlantic Ocean were higher than those from the Pacific Ocean. Apparently the source of ^{228}Ra in surface waters is diffusion from ^{232}Th-bearing sediments in contact with these waters. Deep water samples collected <100 m from the sea floor have significant ^{228}Ra concentrations. Apparently ^{228}Ra is diffusing from deep-sea sediments as it is from nearshore sediments. Deep Pacific samples were generally lower than deep Atlantic samples. This may mean that ^{228}Ra released from Pacific sediments is mixed upward more rapidly, thereby decreasing the near-bottom concentrations. Intermediate water samples had less ^{228}Ra than either surface or bottom samples from the same area. These concentrations were near the lower limit of detection. Because the vertical mixing rate of the ocean is much greater than the mean life of ^{228}Ra, little ^{228}Ra can penetrate into the intermediate ocean. (auth)

334 ^{228}Th IN MARINE PLANKTON AND SEA-WATER. Cherry, R. D. (Univ. of Cape Town); Gericke, I. H.; Shannon, L. V. Earth Planet. Sci. Lett., 6: 451-6(Sept. 1969).

Data are given for thorium-228 in zooplankton, phytoplankton, and seawater from seven different oceanographical water masses in the South Atlantic and around the Southern African coast. The levels in plankton were easily detectable, being up to 27×10^{-15} g thorium-228 per g wet zooplankton and up to 65×10^{-15} g thorium-228 per g wet phytoplankton. What appear to be real variations from one water mass to another are observed, and the possible utility of thorium-228 as a natural oceanographic tracer is noted. The levels in seawater were in general at or below the sensitivity level of the technique used, but for one set of samples a particularly high thorium-228 content of 2.7×10^{-15} g thorium per liter seawater was obtained. This set was from the Walvis Ridge area, and attention is drawn to the fact that this region is likely to be particularly interesting as far as thorium and certain other trace elements are concerned. (auth)

Seismology

Refer also to abstracts 337, 341, 344, and 1183.

335 (JAB-99-73) ENGINEERING INTENSITY SCALE FOR EARTHQUAKES AND OTHER GROUND MOTION. Blume, John A. (Blume (John A.) and Associates Research Div., San Francisco, Calif.). Sept. 1969. Contract AT(26-1)-99. 22p. Dep. CFSTI.

An engineering intensity scale is proposed for earthquakes and for ground motion resulting from nuclear or chemical explosions. It is based upon 5% damped response spectra developed from the ground motion and a standard 10 × 9 matrix with columns representing period bands and rows representing prescribed response velocity levels, S_v. Acceleration or relative displacement can also be readily assigned with the use of 4-way logarithmic paper. The EI scale can be reported by period column as 9-digit, 3-digit, or 1-digit numbers, or by all three in a standard format. The more digits reported, the greater the amount of information on the period bands. The advantages over existing scales are many, including ratings that are directly informative and useful in damage estimations. The ratings are made objectively, and have period identification lacking in other scales. Some examples of EI ratings are provided. (auth)

336 EXCITATION OF RAYLEIGH WAVES. Shurbet, D. H. (Texas Technological Coll., Lubbock). J. Geophys. Res., 74: 5339-41(Oct. 15, 1969).

Rayleigh waves recorded at Lubbock, Texas, from natural earthquakes and from nuclear explosions are compared. Natural earthquakes generate both first-mode and second-mode Rayleigh waves, but the explosions generate only first-mode Rayleigh waves. Absence of second-mode Rayleigh waves from the explosions is related to a lack of SV energy in the source mechanism. (auth)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 265, 336, 367, 411, 484, and 1972.

337 (CEA-R-3749) DAMAGE CAUSED TO HOUSES AND EQUIPMENT BY UNDERGROUND NUCLEAR EXPLOSIONS. Delort, Francis; Guerrini, Charles (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). June 1969. 23p. (In French). Dep. CFSTI (U. S. Sales Only).

The damage to various structures, buildings, houses, mechanical and electrical equipment caused by underground nuclear explosions in granite is described. For each type of equipment or building, the limiting distances for a given degree of damage are given. These distances have been related to a parameter characterizing the movement of the medium; thus it is possible to generalize the results obtained in granite, for different media. The problem of estimating the damage caused at a greater distance from the explosion is considered. (auth)

338 (CEA-R-3779) UNDERGROUND NUCLEAR EXPLOSIONS. GEOLOGICAL SURVEY OF THE CAVITIES. Faure, Jean (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). July 1969. 25p. (In French). Dep. CFSTI (U. S. Sales Only).

A geological survey of underground nuclear explosions makes it possible to determine the main characteristics of the cavity formed. The lower portion is spherical; the same was very likely true of the roof, which collapses in the majority of media with the exception of rock-salt. Its radius, for a given bomb size, can vary by a factor of two according to the type of rock. The layout of its contents depends on the characteristics of the solid and liquid products at the moment of the roof's collapse; according to the medium involved, mixing of the rubble and the mud-flow occurs (granite) or does not occur (tuff and alluvia). In all media the average physical properties can be evaluated. (auth)

339 (FOA-4-4401-28) CHEMICAL FRACTIONATION IN AIR-BURST DEBRIS. Andersson, S.; Holmberg, B. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Sept. 1969. 5p. Dep. CFSTI (U. S. Sales Only).

Air-burst debris contain particles which vary in composition, which can be explained by a mechanism named fractionated condensation. The effects on the particle formation material or by making chemical additions to this, are discussed. (Sweden)

340 (NCG-TR-17) PROJECT TANK TRAP: A FIELD EVALUATION OF NUCLEAR TERRAIN BARRIERS. (Army Engineer Nuclear Cratering Group, Livermore, Calif. Army Tank-Automotive Command, Warren, Mich. Land Locomotion Lab.). June 1969. 83p. Dep. CFSTI.

Project TANK TRAP was conducted to determine the capability of selected tactical vehicles to traverse craters typical of those which could be produced with Atomic Demolition Munitions (ADM). The vehicles included in the test program were the M-60 Tank, M-113 Armored Personnel Carrier, and an articulated two-unit general purpose vehicle called the POLECAT. Trafficability testing of these vehicles was performed in the SCOOTER crater, the JANGLE U crater, and Pre-SCHOONER BRAVO crater. The results of the research project indicate that craters formed in dry soil by the detonation of explosives at the surface or at very shallow depths of burst (down to approximately 20 ft/kt$^{1/3.4}$) do not present significant trafficability problems to tracked tactical vehicles; craters formed at or near optimum depth of burst (~160 ft/kt$^{1/3.4}$) in dry soil are a trafficability obstacle to tracked tactical vehicles; and craters formed in hard rock, such as basalt, cannot be negotiated by tracked tactical vehicles without major modification of the crater and/or assistance by heavy duty equipment, either mobile or fixed. (auth)

341 (NVO-1163-TM-8) PSRV PREDICTION EQUATIONS FOR PAHUTE MESA EVENTS. Lynch, Robert D. (Environmental Research Corp., Alexandria, Va.). May 23, 1969. Contract AT(29-2)-1163. 26p. Dep. CFSTI.

Equations for the prediction of pseudo-relative velocity response spectra (PSRV), which were obtained by multiple regression analysis of response spectra derived from ground motion recorded from Pahute Mesa underground nuclear detonations, are presented. The characteristics of the data sample in terms of number of events and stations and the range of yield and distance variables are discussed. The equation relating PSRV to yield and distance is given as well as the results of the statistical analysis. Recommendations are made for the use of the prediction equations to specific situations with particular emphasis on limitations imposed by the data sample. (L.C.L.)

342 (ORNL-4422, pp 272-5) CHEMICAL APPLICATIONS OF NUCLEAR EXPLOSIONS. (Oak Ridge National Lab., Tenn.).

The behavior of radionuclides derived from the use of nuclear devices in the recovery of copper from ore deposits and oil from shales was studied. (M.C.G.)

343 (PNE-1011) GASFIELD AND MINE SURVEY. Project GASBUGGY. Ward, Don C. (Bureau of Mines, Bartlesville, Okla. Bartlesville Petroleum Research Center). June 1968. 131p. Dep. CFSTI.

At the request of the Effects Safety Division of the Atomic Energy Commission's Nevada Operations Office, the Bureau of Mines made an inventory of gas wells and associated facilities out to a radius of 10 miles from Gasbuggy surface ground zero (GZ). All wells and facilities within 5 miles of GZ were examined and photographed in detail, both preshot and postshot. Since some damage was predicted for close-in wells, six of the seven Pictured Cliffs gas wells, at distances between 2,650 and 6,750 feet from GZ, were monitored for pressure changes. No surface damage was sustained by any of the gas wells nor by the test wells near GZ. No subsurface damage was evident beyond the test well cluster. It appears reasonable to assume that no surface damage should occur to similar wells and facilities subject to comparable ground motion. In addition the pre-event and post-event structural conditions at six underground mines were examined and documented to determine any damage caused by Project Gasbuggy. It was concluded that none of the mines sustained any physical damage. (auth)

344 (VUF-1044) STRUCTURAL RESPONSE: STERLING EVENT. (Blume (John A.) and Associates Research Div., San Francisco, Calif.). July 1969. Contract AT(26-1)-99. 19p. Dep. CFSTI.

Sterling event was detonated on December 3, 1966, at 0615 hours CST and involved a 350-ton nuclear device in a decoupled emplacement in Lamar County, near Baxterville, Mississippi. The device was emplaced in the center of 110-foot nominal diameter cavity in the Tatum Salt Dome about 2,700 feet below the earth's surface. The cavity had been created by the SALMON explosion on October 22, 1964. Calculations by others, prior to the Sterling Event, indicated that event-caused ground motion would be negligible. Therefore, no structutes were instrumented for this event. However, nineteen structures in cities and towns surrounding the test site were selected for observation. Residences were chosen for close-in structure monitoring because of the lack of other building types; commercial or institutional structures were selected for the outlying cities and towns. Detailed condition surveys were made on all selected structures, and all information gathered, including photographs, was compiled into a field report that was utilized by observers during the pre-shot, shot-time, and post-shot surveys. Perceptibility reports indicated that motion was felt slightly at only four of the nineteen monitored structures. This observed motion was recorded in the vicinity of residential structures located within a 4.5-mile radius of Ground Zero (GZ). Reports from other observers, official and unofficial, indicate no perceptible motion. There were no indications of Sterling-generated damage. (auth)

345 NUCLEAR EXCAVATION OF AN ELAT-DEAD SEA WATERWAY. Gileadi, Aviva E. (Puerto Rico Nuclear Center, Mayaguez); Talley, Wilson K. J. Waterways Harbors Div., Proc. Amer. Soc. Civil Eng., 95: 329-5(Aug. 1969).

A study group was assembled in 1956 at the Lawrence Radiation Laboratory at Livermore to consider the feasibility of constructing a canal from the Gulf of Aqaba to the Mediterranean by the use of nuclear explosives. The route considered is close to sea level, except for the leg northwest to Gaza which passes through high, basaltic mountains. No nonweapon devices were available, and the study group recommended against the proposal on the grounds of safety and economics. No report of their deliberations has ever appeared in the unclassified literature. While improvements since 1956 in device design and emplacement techniques have markedly reduced likelihood of any release of radiation, the seismic hazard remains unacceptable. This is due to the seismic motions that would be induced by the large yields required for excavation in the mountains near Be'er Sheva. It is suggested that use of nuclear explosives for a waterway from the Gulf of Aqaba to the Dead Sea valley only would be feasible. That is, the waterway excavation would require only moderate yields. The potential hazard of ground motion precludes the possibility that the cut be produced by the simultaneous detonation of all charges. Single shots produce

no excavating enhancement; 4 or more must be detonated simultaneously in a row. Hence, a limit on the yield per detonation must be established and a succession of cuts made. In considering a waterway from Elat to the Dead Sea, because of seismic effects, the construction would have to be conventional up to at least 10 Km north of Elat. Also, there would be a similar safety zone at about the point of closest approach to the ancient copper mines of King Solomon. If it is assumed that this latter zone is a negligible interruption in the nuclear excavation, 400 devices with a total yield of 298 Mt and a cost of $27,1,000,000 would be needed (87 to 50 Kt, 54 to 100 Kt, 65 to 200 Kt, 78 to 500 Kt, 47 to 1 Mt, 52 to 2 Mt, and 17 to 5 Mt). (BBB)

346 NUCLEAR EXCAVATION: REVIEW AND ANALYSIS. Circeo, L. J. Jr. Eng. Geol. (Amsterdam), 3: 5-59 (Jan. 1969).

Nuclear excavation is described as an economical, practical, and beneficial utilization of nuclear explosives, but not yet having passed the testing stage because of the technical, political, and psychological implications. Nuclear cratering technology has been developed to the point where predictions of crater and channel sizes in selected media can be made with confidence. Continuing research is underway to extend basic cratering knowledge to saturated, fine-grained, and stratified media. Significant advances have been made in the evaluation of the magnitude and extent of the potential safety hazards associated with an underground nuclear crater detonation. Progress in nuclear excavation is such that many projects appear feasible now, especially the excavation of harbors, reservoirs, canals, and aggregate production. Nuclear excavation techniques provide a method of alleviating potential catastrophic situations which could result from floods, landslides, and volcanos, where all other measures would be less effective. Safety aspects of nuclear cratering are described. In a nuclear cratering detonation the hazardous effects from thermal and initial nuclear radiation become insignificant, such radiation being completely absorbed by the medium. In fact, these effects significantly contribute to gravity and shock wave formation. The energy from these effects is converted into excavation energy which greatly assists crater formation. The present Plowshare program for using contained nuclear explosions for mining applications is described. Present concepts for mining applications include block-cave mining, in situ leaching of broken ore, retorting oil shale, and increasing the permeability of natural gas fields. (BBB)

347 NUCLEAR TESTING AND THE NEVADA OPERATIONS OFFICE. Miller, Robert E. (Atomic Energy Commission, Las Vegas, Nev.). pp 13-24 of Proceedings of the Tenth Annual Meeting of the Institute of Nuclear Materials Management, Las Vegas, Nevada, April 28-30, 1969. Columbus, Ohio, Institute of Nuclear Materials Management, 1969.

See CONF-690411.

The activities of the Nevada Operations Office including the detonation of underground nuclear explosions for weapons testing and for peaceful applications (Plowshare) are described briefly with some details on the explosion results, safety experiences—both seismic and radiological—budgetary considerations, and the public relations aspects of the operations. (L.C.L.)

348 IMPROVEMENTS IN OR RELATING TO NUCLEAR EXPLOSION DETECTION SYSTEMS. Hicks, Gordon Graham; Fothergill, Reginald Allan; MacGovern, Alan John; Norman, Kenneth George (to UKAEA). British Patent 1,165,331. Sept. 24, 1969. Filed April 25, 1967.

Reference is made to detection systems for nuclear explosions at or above ground level. The system described may also be adapted to give an indication of yield. It employs certain characteristics of the rf and optical transients radiated from a nuclear explosion which occur in a definable time sequence, but are most likely to occur in this time sequence if arising from natural phenomena such as lightning. The object is to provide a sensitive system capable of distinguishing nuclear explosions, down to comparatively low yields and occurring at substantial differences, from naturally occurring phenomena, with a low chance of error. Means are provided for receiving the transient rf signal radiated from the explosion, for deriving from the signal a first output pulse if its rate of rise exceeds a predetermined value, its duration is less than a predetermined time, and its field strength exceeds a predetermined level. Means are also provided for receiving the characteristic fast and slow rising portions of the transient optical signal radiated from the explosion, and converting these to electrical signals, and deriving from the fast rising portion a second output pulse if its rate of rise exceeds a predetermined value and its duration is less than a predetermined time, and also deriving from the slow rising portion a third output pulse if its rate of rise exceeds a predetermined value and its duration exceeds a predetermined time. Means are also provided for causing the occurrence of the first, second, and third output pulses in a predetermined time sequence to indicate a nuclear explosion. The means for converting the portions of the optical signal to electrical signals comprises a photo-voltaic generator connected across transformer primary windings of sufficiently low dc resistance to cause the generator to operate in a substantially linear mode. Means may also be provided for deriving the second output pulse if the amplitude of the fast rising portion exceeds the saturation level of the opto-electrical conversion means for more than a predetermined time. Measurement of the time interval between the occurrence of the fast rising portion and the commencement of the slow rising portion gives an indication of the explosion yield. Various further refinements of such a system are described, involving the generation of up to ten output pulses and the use of coincidence circuits. (UK)

Facilities and Equipment

Refer also to abstracts 340, 436, 437, 487, 514, 515, 941, 967, 985, 992, 995, and 1450–1453.

349 (ANL/EBR-5) STUDY OF LOADING OF EBR-II ELECTRIC POWER SYSTEM. Kacinskas, H. (Argonne National Lab., Idaho Falls, Idaho). July 1969. 21p. Dep. CFSTI.

The results of a study conducted to determine the loading of the electric power supply systems of the Experimental Breeder Reactor (EBR-II) are described. The study includes 138, 13.8, 2.4, 0.480 kV and emergency power supply systems. The general arrangement of the systems, the loads, and the procedures of the study are described. The results of the study indicate that some of the electric power supply systems are overloaded and that their capacity must be increased and the system arrangement modified if a high degree in reliability of power supply to EBR-II electric loads is to be maintained. Several methods of modifying the electric system are proposed. (auth)

350 (TID-4100(Suppl.54)) ENGINEERING MATERIALS LIST. Smith, Richard J.; Sachs, Francis L.; Clark, Willie E. (eds.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Oct. 1969. 43p. DTIE Free.

Twenty-five packages of engineering materials on the following devices are announced for inclusion in TID-4100: nuclear instrument modules; universal spectrometer-3 crystal; high performance, programmable 25 kV, 2 A power supply; revisions to standard manual; magnetoplasma wave device; low voltage test source 1; fuel distribution analyzer; acid concentration monitor; portable cesium irradiator; IC I/O bus extension; strain-measuring system; large gap magnet; mechanical inertial odometers; low gain preamplifier; underwater photometer; cascade dissolvers; on-off liquid helium cryopump; heated transfer tubes; gamma survey meter; vacuum drum filter; radiation detector and recorder; freeze-dry apparatus; rotary film punch; ionization gage controller for 10^{-4} to 10^{-12} torr range; and continuous viewing windows. (L.C.L.)

351 (UCRL-71612) REMOTE METALLOGRAPHY FACILITY AT LAWRENCE RADIATION LABORATORY. Albrecht, E. D.; Johnson, J. M. (California Univ., Livermore. Lawrence Radiation Lab.). Aug. 29, 1969. 32p. (CONF-690920-1). Dep. CFSTI.

From 2nd Annual Technical Meeting of International Metallographic Society, San Francisco, Calif.

A remote metallographic facility has been installed in the β-γ Hot Cells at the Lawrence Radiation Laboratory in Livermore, California. Four of these cells have been devoted to metallography in an effort to prevent contamination of the polishing, etching, and viewing areas by the grinding operation. A preliminary preparation cell has been equipped with a remotized mounting press, specimen edge beveler, and two lapping machines used for two-step specimen grinding. The polishing cell has accommodations for five interchangeable rotating or vibratory polishing machines mounted at floor height. Remote microscopes are installed in the polishing and chemical etching cells. The final cell houses a cathodic etcher and a remotized B and L metallograph. The three working cells are equipped with ultrasonic cleaners which are used after each step in specimen preparation. Cell cleanliness is maintained by use of a central home-type vacuum system and wall-to-wall, stainless steel trays to contain spillage. An electron-microprobe analyzer, capable of handling a 100-curie specimen, is housed in the cell area and specimens are transferred from the polishing cell to the probe by a shielded cart. (auth)

352 (Y-1697) SPINDLE GROWTH COMPENSATION SYSTEM FOR NUMERICALLY CONTROLLED LATHES. Prewett, H. P.; Thompson, C. H. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Nov. 4, 1969. Contract W-7405-eng-26. 26p. Dep. CFSTI.

An automatic spindle-growth compensation system has been developed and installed on a numerically controlled lathe, equipped with a machine tool control unit, at the Oak Ridge Y-12 Plant. An air gage was selected to continually monitor spindle growth and supply a proportional electrical output signal through interface electronics to the lathe control unit. Test results demonstrated that uncompensated spindle growth will have a direct effect on the length dimensions of a workpiece, and the system will maintain the carriage in its programmed position relative to the spindle within ±100 microinches over a six-mil range of spindle growth. (auth)

353 NUCLEAR REACTOR FUEL ASSEMBLY. Krawiec, Donald M. (to Combustion Engineering, Inc.). U. S. Patent 3,475,273. Oct. 28, 1969. Filed Dec. 5, 1967.

Nuclear reactor fuel element assemblies including a flexible retaining plate with perforations which fit over pins extending up from the fuel elements to position the fuel elements and with perforations for coolant flow up through the plate are described. The plate flexes to permit unequal thermal expansion of the fuel elements. Springs hold the plate down on the fuel elements and permit the entire plate to flex and move vertically as required during temperature changes. (Offic. Gas.)

354 PRESTRESSED CONCRETE CONTAINMENT VESSEL FOR GINNA NUCLEAR POWER PLANT. Croneberger, Don K. (Gilbert Associates, Inc., Reading, Pa.). Civil Eng. (N. Y.), 39: 52-5(July 1969).

A description is given of the containment vessel for the Robert Emmett Ginna Nuclear Power Plant of the Rochester Gas & Electric Corporation, now under construction on the south shore of Lake Ontario 18 miles east of Rochester, N. Y. The reinforced concrete containment structure employs such concepts as prestressing in the vertical direction (the first use of prestressing for a U. S. commercial utility's nuclear containment structure), prestressed rock anchors, and hinge at base-to-cylinder discontinuity. To ensure the integrity of this structure, a pneumatic pressure test was performed at 69 psig (115% of the design pressure) in April 1969, and data were acquired which confirmed satisfactory structural response and peak tightness. The containment structure is a concrete vertical cylinder with a flat base and a hemispherical dome. It has a welded steel liner attached to the inside face of the concrete shell, solely to ensure a high degree of leak tightness. The thickness of the liner in the cylinder and dome is nominally $\frac{3}{4}$ in., and in the base and sumps is $\frac{1}{4}$ in. The use of rock anchors for the containment structure eliminates the need for a heavily reinforced concrete base mat which would have required a thickness of 9 ft. The bottom end closure is, therefore, structurally provided by the rock mass and not the base slab. A detailed description of components is presented. (BBB)

355 GAMMA IRRADIATION UNITS. Tsuda, Eiichi (Mitsubishi Electric Corp., Amagasaki, Japan); Imai, Hikaru. Mitsubishi Denki Giho, 43: 1209-14(Sept. 1969). (In Japanese).

Gamma irradiation units are devices equipped with radioisotopes radiating gamma rays such as ^{60}Co and ^{137}Cs. They are used not only for research purposes in various fields such as agriculture, physical sciences, and engineering but also for sterilization of medical instruments, food irradiation for long preservation, or industrial application such as polymerization and wood plastic combination all over the world. Mitsubishi manufactures irradiation apparatus for research, industry, and medicine. The latest devices are described. The devices cover those for research, standard units for general radiation chemistry, relatively simple calibration units, and special types making underwater radiation with 100,000 Ci large scale sources. (auth) (NSA of Japan)

356 APPARATUS FOR CARRYING OUT RADIATION-CHEMICAL AND MICROBIOLOGICAL INVESTIGATIONS. Kaushansky, D. A.; Kaljanov, D. M.; Bibergal, A. V.; Emelianov, K. N.; Eletsky, D. Y.; Frolov, E. V.; Lutsek, V. P. (to Institute Organicheskoi Khimii im. N. D. Zelinskogo). Canadian Patent 811,245. Apr. 22, 1969.

An apparatus is described which has a working chamber whose physical parameters are stable under conditions of high pressure or vacuum and allow circulation of reagents during chemical investigations. The irradiator may be charged with radioactive rods under ordinary operating conditions. It consists of a split container with a collar, the container housing a cylinder-shaped hollow irradiator. A changeable working chamber is mounted in the irradiator by means of a lifting mechanism. There are also upper and lower changeable plugs. The collar comprises a solid ring, housing a shutting device to prevent the escape of γ radiation. Other safety devices provided are also described. (F.S.A.)

357 TURBOGENERATORS FOR NUCLEAR POWER PLANTS. Wanke, Karl. Tech. Mitt. AEG-Telefunken, 59: No. 1, 1-10(1969). (In German).

The largest turbogenerators in operation or under construction at the present are designed for powers of about 1400 MVA. These machines are single phase and are operated by multihoused steam turbines. A significant increase in the efficiency of the active generator volume as a function of the apparent output is connected with the combination of the steam and turbogenerators. The design of a four-pole turbogenerator with 300 to 800 or 1300 MVA is described. The test results of a water-cooled turborotor with 1140 mm diameter and current up to 10 kA are reported. (tr-auth)

358 COMPARISON OF FLUID, ELECTRIC, AND COMPOSITE CONTROL DEVICES. III. EXAMPLES OF ELECTRICAL TYPE CONTROL DEVICES. Cambornac, Michel. Rev. Gen. Elec., 78: 587-94(June 1969). (In French).

Two examples of position control devices are described; one of these is a 1200 metric ton control bridge for the loading of the EDF 2 nuclear reactor at Chinon. The extremities of the bridge are positioned to within 2 mm, and the bridge has no axis. The slightest desynchronization of positioning of the two ends can cause the stoppage of the whole installation. The motorization of the bridge ends is effected by two 25 hp electric motors controlled by a Ward Leonard group and magnetic amplifiers. Static precision requires a triple synchromachine system; dynamic performance is limited to that necessary to avoid a shutdown by desynchronization. The importance of good mutual understanding between engineers cooperating in this sort of project is stressed. (BBB)

359 CATHODIC ETCHER. Ludlow, J. O.; Coleman, L. F.; Drabek, Vera; Ross, L. E.; Slawecki, M. A. (Argonne National Lab., Ill.). pp 309 of Proceedings of the 16th Conference on Remote Systems Technology. Hinsdale, Ill., American Nuclear Society, Inc., 1969.

From Remote Handling and Examination in the Fast Reactor Field Meeting, Idaho Falls, Idaho. See CONF-690305.

A cathodic etcher is described which is arranged so that all metal exposed in the vacuum except the sample surface is at anode potential. This nullifies the cathodic action which usually occurs in etches of this type. Details of etcher design are included. (J.R.D.)

360 IMPROVEMENTS IN OR RELATING TO ELECTRIC GENERATORS. Russell, Francis Michael (to Science Research Council). British Patent 1,165,182. Sept. 24, 1969. Filed Jan. 6, 1967.

Reference is made to generators capable of producing high voltage dc. A requirement for such a generator has arisen in connection with the separated orbit cyclotron in which the power to accelerate a pulsed beam of charged particles is derived from pulsed beams of very high energy electrons circulated through the cavities of the cyclotron in an orbit outside the outermost turn of the spiral path followed by the charged particles. The required beams of electrons are accelerated in linear accelerators prior to entering the cyclotron, and the generator is required to provide the power to energize the accelerating electrodes of these accelerators. The generator described comprises a rotor formed by an insulating shaft made up of a number of annular magnet sections having outwardly projecting pole pieces the polarities of which alternate around each section; a torque-transmitting disk is interposed between each adjacent pair of magnet sections, with its plane normal to the rotor axis. Each disk is secured to the adjacent magnet sections and insulated therefrom by synthetic resin. The stator is coaxial with the rotor and is made up of annular sections having inwardly projecting members, the number of stator sections being equal to the number of rotor magnet sections. Each projection has a coil wound thereon; ac is developed in these coils as the rotor rotates. Rectifier means are associated with each coil. Several designs of torque-transmitting disks are described. (UK)

Heat Transfer and Fluid Flow

Refer also to abstracts 993, 1063, 1339, 1976, 1979, 1985–1987, 1989, and 2062.

361 (AECL-3281(Rev.)) AN INVESTIGATION OF HEAT TRANSFER IN THE LIQUID DEFICIENT REGIME. Groeneveld, D. C. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Dec. 1968; Revised Aug. 1969. 56p. Dep. CFSTI (U. S. Sales Only). CAN $1.50.

Heat transfer data were obtained for forced convection steam–water flow in a 0.760" O.D., 0.600 I.D. annulus at pressures between 600 and 1200 psia and mass velocities up to 3.0×10^6 lbm/h.ft^2. A literature survey of stable film boiling heat transfer

covered several fluids at a wide range of pressures and the existing theories on film boiling were reported. A variety of correlations were compared with the available world data. Three new correlations were developed—for tubes, annuli, and tubes and annuli combined. The RMS error was respectively 10.1%, 11.2%, and 12.7%. (auth)

362 (AERE-R-5374) LIQUID ENTRAINMENT IN ADIABATIC STEAM–WATER FLOW. Hewitt, G. F.; Pulling, D. J. (Atomic Energy Research Establishment, Harwell (England)). June 1969. 11p. Dep. CFSTI (U. S. Sales Only). UK 2s. 6d.

Measurements of liquid entrainment are reported for the annular flow of steam–water mixtures in the pressure range 25 to 50 psig in a 0.366 in. bore tube. The mass velocity was fixed at 2.19×10^5 lb/ft^2 hr in the quality range 10 to 80%. The entrainment was determined by measuring the film flow using a porous wall device and subtracting this film flow from the known water flow. The entrainment flowrate passed through a maximum with increasing quality. Comparison of the data with the correlation of Truong Quang Minh and Huyghe (1965) showed systematic variations, and it seems that correlations of this relatively simple type are inadequate in describing equilibrium entrainment data. (auth) (UK)

363 (GEAP-10067) TWO-PHASE FLOW AND HEAT TRANSFER IN MULTIROD GEOMETRIES. Quarterly Progress Report No. 15, April 1–June 30, 1969. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Aug. 1969. Contract AT(03-4)-189. 17p. Dep. CFSTI.

Subchannel sampling tests were continued in the side and center subchannels. Results of measurements of the mass velocity and enthalpy for these subchannels and the overall trends are reported. Pressure drop results for the nine-rod assembly are also given. (auth)

364 (LA-4149) A NUMERICAL METHOD FOR SOLVING THE BOUNDARY LAYER EQUATIONS FOR GAS FLOW IN CIRCULAR TUBES WITH TRANSFER AND PROPERTY VARIATIONS. Bankston, C. A.; McEligot, D. M. (Arizona Univ., Tucson. Dept. of Aerospace and Mechanical Engineering. Los Alamos Scientific Lab., N. Mex.). Apr. 7, 1969. Contract W-7405-eng-36. 42p. Dep. CFSTI.

Details of the formulation and use of a finite difference method for solving the boundary layer equations for steady gas flow in circular tubes are given. The method employs an implicit scheme which has proved to be stable even under highly nonlinear circumstances. Problems involving heat transfer with strong property variations in laminar or turbulent flow under arbitrary thermal boundary conditions can be solved. (auth)

365 (LA-4154) CALCULATION OF HEAT TRANSFER TO GASES FLOWING IN A CIRCULAR TUBE WITH ARBITRARY WALL HEAT FLUX DISTRIBUTIONS. Bankston, C. A.; McEligot, D. M. (Los Alamos Scientific Lab., N. Mex.). Apr. 17, 1969. Contract W-7405-eng-36. 15p. Dep. CFSTI.

Calculation of Nusselt numbers and wall temperatures for turbulent and laminar pipe flows with varying thermal boundary conditions by the method of superposition was investigated. Superposition of eigenvalue solutions and empirical correlations were employed, and both constant-property and variable-property fluids are considered. It was shown that accurate results can be obtained by this method provided that the superposition is properly formulated and, in the case of property variations, that the transverse temperature gradients are not too severe. (auth)

366 (RPI-3639-9) STUDIES OF GAS–PARTICLE HEAT TRANSFER COEFFICIENTS IN PACKED AND FLUIDIZED BEDS BY FREQUENCY RESPONSE TECHNIQUES. Annual Progress Report, January 1–December 31, 1969. Littman, Howard (Rensselaer Polytechnic Inst., Troy, N. Y.). Sept. 1969. Contract AT-(30-1)-3639. 7p. Dep. CFSTI.

Experimental data are given for the gas-particle heat transfer coefficient at Reynolds numbers between 2 and 100 using a model which takes into account axial dispersion of heat in the gas phase and axial conduction in the solid phase. Beds of copper, glass, and lead were used with particle sizes ranging from 0.0198 to 0.080 in. dia. Dynamic thermal conductivities of the solid phase in the direction of flow were measured simultaneously. Other experiments performed have extended the Reynolds number range down to 0.3. Work is proceeding on the extension of the conduction-dispersion model to account for radial gradients in packed beds. (J.C.W.)

367 (UCRL-50664) TRUMP COMPUTER PROGRAM: CALCULATION OF TRANSIENT LAMINAR FLUID FLOW IN POROUS MEDIA. Edwards, Arthur L. (California Univ., Livermore. Lawrence Radiation Lab.). May 1969. 39p. Dep. CFSTI.

The TRUMP program solves a general nonlinear parabolic partial differential equation, using an efficient and accurate numerical method. TRUMP was initially developed to solve problems involving heat transport and chemical reaction in multidimensional systems with arbitrary geometric configurations, initial and boundary conditions, and thermal and chemical properties, and with various modes of heat production and transport. A variety of mathematically analogous problems may be solved. The solution of transient or steady-state flow of a compressible fluid in a porous, permeable medium is described. This type of problem is of particular interest in the Plowshare Project experiments being carried out to determine the feasibility of using nuclear explosives to stimulate gas recovery from low-permeability gas-bearing formations. (auth)

368 ILLUSTRATION OF THE PROBLEM OF STUDY OF A TEST CIRCUIT FOR STEAM GENERATORS HEATED BY SODIUM (C.G.V.S.). Clayer, Michel (GAAA, Le Plessis-Robinson, France). Ind. At., 13: No. 7-8, 59-68(1969). (In French).

Sodium water vapor circuits which were used to successively test several generator prototypes are described. The technical problems associated with the construction of various circuits were examined, and the difficulties involved in the operational program such as the multiplicity of possible regimes which led to certain structural complexity and the number of rapidly variable regimes which required meticulous study of their functioning and many precautions intended to avoid mishaps and precocious aging are discussed. (auth)

369 FLOW CONTROL. Lewis, William Edward (to English Electric Co. Ltd.). British Patent 1,160,994. Aug. 13, 1969. Filed Feb. 5, 1968.

A means for controlling the flow of a fluid in a duct of non-variable cross section is described. A flow bypass is included in the duct, with an inlet end for diversion of some fluid from the duct into the bypass, the exit end of the bypass being arranged so as to direct the diverted fluid into the duct in the opposite direction to the main flow, thereby reducing the velocity of the main flow. Parts are provided for directing one or more fluid control jets into the fluid upstream of the inlet end of the bypass in a direction so as to vary the flow of fluid into the bypass. A further bypass may be included the inlet end of which leads from an intermediate point of this second bypass, while the exit end is arranged so as to direct fluid from the second bypass into the duct not in the opposite direction of the main flow. This flow control means can be incorporated in a fuel channel of a nuclear reactor for control of coolant fluid through the channel. A number of reactor applications are described in detail. (UK)

370 HEAT TRANSFER AND HYDRAULIC RESISTANCE TO ARGON FLOWING IN A PIPE WITH HIGH WALL TEMPERATURE. Tolubinskii, V. I.; Minya'lenko, N. A. (Inst. of Thermophysics, Kiev). Heat Transfer - Sov. Res., 1: 7-12(May 1969).

Nuclear power production and the use of plasma for power production and engineering purposes demand studies of high-temperature heat transfer. Heat transfer between the wall of a duct and a gaseous heat transfer agent at high temperatures provides a case where the physical properties of the gas vary appreciably not only over the cross section, but also along the duct. An experimental study was performed to determine the heat transfer and friction factors for Ar flowing in Mo tubes under the following conditions: wall temperature 1470 to 1865°K, inlet temperature to test section 320 to 710°K, outlet temperature 874 to 1147°K, temperature factor $T_w/T_{fl} = 1.26$ to 3.8, inlet Reynolds number $Re_{in} = (19 \text{ to } 40) \cdot 10^3$, tube dia 10 to 12 mm, tube length 500 to 800 mm. In all experiments the heat transfer coefficient was lowest in the region with the maximum temperature factor. After the initial section a reduction in the zonal heat transfer coefficients was observed; then they became steady, finally increasing again toward the end of the tube. This behavior is attributable to the initial increase and subsequent reduction in the temperature factor. The Prandtl number varied slightly in the experiments, in the range of 0.636 to 0.65. Physical properties and density were calculated at the wall temperature T_w, bulk temperature T_{fl}, and their mean. A schematic of the experimental equipment is diagrammed. (BBB)

371 FLUID MECHANICS AND MEASUREMENTS IN TWO-PHASE FLOW SYSTEMS. A Symposium Held at the University of Leeds, 24th–25th September 1969. London, Institution of Mechanical Engineers, 1969. 176p. (CONF-690922).

Twenty-one papers on fluid mechanics and measurements in two-phase flow systems are presented. Separate abstracts were presented. Separate abstracts were prepared for 4 which contained information applicable to flow conditions in reactor cooling systems. Seventeen papers were not considered within the scope of NSA. (L.C.L.)

For abstracts of individual papers see: 372–374 and 1989.

372 VELOCITY OF SOUND AND CRITICAL DISCHARGE PRESSURE IN ANNULAR TWO-PHASE FLOW. White, R. F.; D'Arcy, D. F. (Atomic Energy of Canada, Ltd., Chalk River, Ont.). pp 35–44 of Fluid Mechanics and Measurements in Two-Phase Flow Systems. London, Institution of Mechanical Engineers, 1969.

From Symposium on Fluid Mechanics and Measurements in Two-Phase Flow Systems, Leeds, England. See CONF-690922.

The effects of a rapid loss of coolant caused, for example, by the fracture of a pipe in the primary coolant circuit play an important part in the safety assessment of a water-cooled nuclear reactor. In particular, it is essential to know the rate of decrease of coolant density in the core and the rate of discharge of coolant into the containment space. It is uneconomic to obtain this information from experiments on each new reactor. Consequently computational methods, supported by experiments on basic elements of a coolant circuit, are being developed which will be applicable to a wide variety of reactors. An experiment is described in which fundamental information on fluid flow dynamics was obtained. A flow of two-phase water at high pressure was established in a straight pipe 15 ft long and 0.621 in. i.d. At the downstream end of the pipe a rupture disc was suddenly burst. The pressure versus time histories at three locations along the pipe were recorded, using fast response pressure transducers and a multichannel oscilloscope. Experimental results are given for pre-blowdown pressures of 500 and 1000 lb/in.^{2} (abs.) and steam qualities of 10 to 30 per cent. The mass flux was 0.6×10^6 lb/ft^2 h, and the flow regime was annular. From the recorded pressure traces, the speed of the head of the rarefaction wave travelling upstream into the fluid was measured and also the pressure at critical flow conditions as functions of the pre-blowdown conditions. These measurements are compared with values calculated from steam tables. (auth)

373 EFFECT OF BY-PASS CHARACTERISTICS ON PARALLEL-CHANNEL FLOW INSTABILITIES. Carver, M. B. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 86–94 of Fluid Mechanics and Measurements in Two-Phase Flow Systems. London, Institution of Mechanical Engineers, 1969.

From Symposium on Fluid Mechanics and Measurements in Two-Phase Flow Systems, Leeds, England. See CONF-690922.

Experiments on parallel-channel hydrodynamic stability frequently use one heated channel operating in parallel with an unheated by-pass. This arrangement is designed to simulate the operation of a channel in a boiling water reactor, the by-pass providing the essentially constant pressure drop which the remaining channels impose on the channel. If the ratio of by-pass flow to channel flow is large, the changes in the channel flow do not significantly affect the overall pressure drop; however, particularly in experiments using full-scale reactor fuel channels, loop capacity may limit this by-pass ratio. In this case the pressure drop is no longer constant. It is shown, analytically, that a low by-pass ratio, resulting in a variable overall pressure drop, significantly affects the dynamic behavior of the heated channel. Both the power at threshold of flow oscillation and the natural frequency of the system are shown to depend on by-pass characteristics. In particular, a heated channel operating with a low by-pass ratio is normally stable to much higher powers than with a high by-pass ratio. A linearized analysis is presented which illustrates the effect of by-pass resistance and inertia on the threshold power and natural frequency of flow oscillations. The analysis is incorporated in a computer code, and resulting threshold powers and oscillation frequencies are compared with data from experiments using a full-scale simulated reactor channel in parallel with a by-pass. It is concluded that the finite unheated by-pass does not accurately simulate the dynamic effect of the remaining reactor channels on a particular channel. The methods should, however, prove useful in interpreting results from a flow-limited test loop and extrapolating to the full reactor case. (auth)

374 TWO-PHASE CRITICAL FLOW UNDER DIABATIC CONDITIONS. Bergles, A. E.; Kelly, J. T. (Massachusetts Inst. of Tech., Cambridge). pp 129–35 of Fluid Mechanics and Measurements in Two-Phase Flow Systems. London, Institution of Mechanical Engineers, 1969.

From Symposium on Fluid Mechanics and Measurements in Two-Phase Flow Systems, Leeds, England. See CONF-690922.

An experimental investigation of steam-water critical flow in heated tubes is described. A wide range of data was taken for water at pressures below 100 psia in tubes of small diameter. It was demonstrated that critical flow conditions can occur in subcooled boiling at low exit subcoolings. At equilibrium qualities below about 0.04, the data differ significantly from adiabatic data for a similar exit geometry. The deviations can be explained in terms of the additional non-equilibrium effects present in heated flows. For higher qualities, the diabatic data are in good agreement with adiabatic data, and can be approximately predicted by a slip equilibrium model. (auth)

Isotope Technology

Refer also to abstracts 65, 314, 355, 393, 401, 431, 459, 536, 995, 998, 1823, and 1972.

375 (AI-AEC-12875) LARGE RADIOISOTOPE HEAT SOURCE CAPSULE (LRHSC) EIGHTH QUARTERLY PROGRESS REPORT, APRIL–JUNE 1969. (Atomics International, Canoga Park, Calif.). Aug. 15, 1969. Contract AT(29-2)-2338. 69p. Dep. CFSTI.

Progress on the development of a large radioisotope heat source capsule capable of operating in a space environment at a surface temperature of about 2000°F for five years or more is reported. The objectives of the present phase are to design, fabricate, test, and evaluate a test capsule. The following tasks were accomplished: the microstructures of tantalum base alloy components were determined and documented; metallurgical analyses of all abort fire capsule samples and impact capsules were completed; other metallurgical analyses were initiated; the deep drawing of six structural shells and the assembly of a creep capsule and impact capsule were completed; capsule creep testing of T-111 structural shells and impact and fire testing of sample capsules continued. (L.C.L.)

376 (DP-1166) PREPARATION OF A HIGH ENERGY GAMMA SOURCE BY ELECTRODEPOSITION OF ^{228}Th FROM FUSED SALTS. Propst, Robert C.; Overman, Robert F.; McMillan, Thomas S.; Edeburn, Earl J. Jr. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). June 1969. Contract AT(07-2)-1. 38p. Dep. CFSTI.

A remote operation procedure is described for the preparation of sources containing several curies of ^{228}Th for photoneutron counting. The neutrons from (α,n) reactions in the source are reduced by electrodepositing the ^{228}Th from a molten cesium chloride–lanthanum chloride mixture into a liquid bismuth cathode. Sources prepared by this method have less than 6% of the neutron background of $Th(NO_3)_4$ sources. The deposition efficiency for the process is 60 to 75%. (auth)

377 (DP-1206-1) SAVANNAH RIVER LABORATORY ISOTOPIC POWER AND HEAT SOURCES. PART I. ^{60}Co. Quarterly Progress Report, April–June 1969. Angerman, C. L.; Ross, C. P. (comps.) (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Aug. 1969. Contract AT(07-2)-1. 21p. Dep. CFSTI.

Techniques were established for fabricating wafers of CoO, (Co,Mg)O, and $CoAl_2O_4$ at >85% of theoretical density, and for fabricating assemblies for irradiation of these wafers to high specific activity. Thermal expansion coefficients and oxidation properties of CoO and (Co,Mg)O were measured. Composition and properties of 44 superalloy encapsulating materials were evaluated. Destructive examination confirmed the satisfactory performance of an inactive Hastelloy X capsule at 1000°C for 10,000 hr. Radioactive capsules of Haynes 25, Inconel 600, and Hastelloy X reached their goal exposure of 5000 hr at 1000°C. Ten tungsten capsules were purchased for weld development and long-term compatibility tests with cobalt metal at ~1200°C. Inconel 702 was recommended as a possible core material for the WANL 30 kW(t) demonstration heat source because of its oxidation resistance and relatively high thermal conductivity compared with other superalloys. (auth)

378 (INR-P-1057) THE MEASUREMENT OF THE SOLID-PHASE-SLIP OF THE STOWING MIXTURE USING RADIOISOTOPES. Korbel, K. (Institute of Nuclear Research, Warsaw (Poland)). 1969. 26p. (In Polish). Dep. CFSTI (U. S. Sales Only).

Principles and results of flow measurements performed at an industrial storage plant are presented. Results show the relative velocity of solid phase as function of the mean mixture density and grain size. On the basis of results obtained the quantitative dependencies between the real-density and the transport-density of the mixture are determined. Recommendations concerning the possibilities of the washing-up of the large solid particles are included. (auth)

379 (NUMEC-3731-18) RADIOISOTOPE POWERED CARDIAC PACEMAKER PROGRAM. Second Term Report, Phase I. (Nuclear Materials and Equipment Corp., Apollo, Pa. Energy Conversion Div.). Aug. 25, 1969. Contract AT(30-1)-3731. 86p. Dep. CFSTI.

The electrically heated mock-up system has continued to operate in a vacuum system, and has accumulated 12,072 hours of operation

without any degradation of the thermopile. The first plutonium-238 fueled nuclear battery and two complete pacer systems were fabricated. The performance of these units in regard to the electrical output power of the nuclear batteries was below the design objective of 160 microwatts. The generator deficiency was examined by means of a large number of parametric experimental examinations and tests that led to the specification of a larger thermal size of the plutonium-238 heat sources, which are planned for six experimental model generators. The manner in which the increased fuel prediction was prepared, and the experimental verification of the performance of a nuclear battery that confirmed the increased fuel loading prediction are discussed. After the increased fuel prediction was completed, but before the heat sources containing the larger fuel loading was received, two additional complete pacer systems were fabricated. Component development related to the various fueled experimental models including, electrical feedthroughs, a stabilizing insulation coating for insulation tapes, a getter for gaseous contaminants, and other components are described. The first dose rate measurements of a complete pacer were performed and a series of safety pressurization tests of simulated inner fuel capsules of the previously defined maximum credible fire conditions were reproduced. (J.C.W.)

380 (ORNL-4422, pp 230-8) SOL-GEL PROCESSES FOR ISOTOPIC HEAT SOURCES. (Oak Ridge National Lab., Tenn.).

Laboratory studies of $^{238}PuO_2$ sol-gel process, developmental studies in a glove box system, assistance to Mound Laboratory, and curium sol-gel studies are described. (M.C.G.)

381 (SC-RR-69-360) TRAJECTORIES AND REENTRY ENVIRONMENTS FOR THE ALRH DURING MULTIPLE REVOLUTION HIGHLY ELLIPTICAL ORBITAL DECAY AFTER SUPERCIRCULAR VELOCITY REENTRY. Spahr, H. R. (Sandia Labs., Albuquerque, N. Mex.). Aug. 1969. 286p. Dep. CFSTI.

Trajectories and reentry environments are presented for the Apollo Lunar Radioisotope Heater (ALRH) during multiple revolution highly elliptical orbital decay after shallow angle supercircular velocity reentry. The trajectories and reentry environments from a closed form approximate solution and from numerical integration of the equations of motion are compared for two of the five perigee altitudes investigated. (auth)

382 STANDARDIZATION OF METHODS FOR CHECKING GAMMA SOURCES. Karavaev, F. M.; Yudin, M. F.; Ostromukhova, G. P.; Drichko, A. F. Izmer. Tekh., No. 5, 68-70(May 1969). (In Russian).

Descriptions are given of two sets of standards for secondary discharge measurements of γ radiation from a ^{226}Ra source and secondary of γ radiation from ^{60}Co, ^{137}Cs and ^{226}Ra (according to the intensity of the exposed dose). Descriptions are also given of instrumentation used for verifying the obtained data. (tr-auth)

383 MOLDED APPLICATOR FOR CARRYING RADIOPHOSPHORUS (NEW METHOD). Lecacheux, B.; Robillard, J.; Abbattuci, J. S.; Couette, J. E. (Centre Anti-Cancereux, Caen, France). Bull. Group. Int. Rech. Sci. Stomatol., 11: 129-38(Jan. 1968). (In French).

A plastic applicator which allows ^{32}P to be used for cutaneous radiotherapy while protecting healthy tissues is described. Radiophosphorus with its 1.7-MeV β emission is ideally suited for treating hemangiomas. Compared with Ra, all of the ^{32}P radiation is absorbed in the surface of skin. A polyvinylchloride base was used to support the radioisotope. A double thickness backing of octyl phthalate and of Ca stearate was used to protect the operator. The radioactive surface was so prepared that it precisely included the borders of the skin lesion to be irradiated. A method is described for preparing a cast of the part to be irradiated which can be reproduced in the plastic to form an applicator. Use of the applicator to treat lesions on the face of infants is illustrated. (BBB)

384 CHARACTERISTICS OF ELECTRIC GENERATORS FOR THE DIRECT PRODUCTION OF ELECTRIC ENERGY BY THE DECAY OF BETA-EMITTING RADIOISOTOPES. Piskunov, M. M.; Favorskii, O. N. Izv. Akad. Nauk SSSR, Energ. Transp., No. 4, 106-14(July-Aug. 1969). (In Russian).

The physical phenomena which forms the basis for the operation of direct energy conversion devices that convert the kinetic energy of radioisotope decay into electric energy are discussed. A study was conducted of the characteristics of generators employing the beta-emitting radioisotopes ^{144}Ce, ^{95}Nb, ^{191}Os, ^{210}Po, ^{185}Re, and ^{89}Sr. A comparison of the efficiencies of generators employing one-dimensional, two-dimensional, cylindrical, and spherical radioisotope heat sources is given. The study showed that cylindrical and two-dimensional geometries produced nearly identical performance. The most efficient generator was found to have a two-dimensional geometry with a 12.5 mg/cm^2 ^{89}Sr heat source and a 500 mg/cm^2 aluminum collector. Curves are given showing the relationship between generator efficiency and the thickness of the radioisotope heat source. (tr-auth)

385 A SYSTEM OF CONTINUOUS WEIGHING OF A TRANSPORTED MASS BY MEANS OF RADIOISOTOPES. Seda, Josef (Technische Univ., Prague). Atompraxis, 15: 315-19(Sept.-Oct. 1969). (In German).

The problem of weighing a transported mass by means of radioisotopes is discussed. Two methods—scattering and absorption—are considered, and their application for the construction of a radioisotope scale is discussed. It is shown that the application of scattering method is substantially limited in comparison with absorption method with a linear attenuation characteristic. An electronic evaluating system of the radioisotope scale which digitally performs necessary mathematical operations so that the weight could be read on the output of the system just after the measurement is over, is outlined. The system is capable of handling both variable weight of transported mass and variable conveyor speed. (auth)

386 DIRECT COLLECTION OF SOME METAL IONS IN AN ELECTROMAGNETIC ISOTOPE SEPARATOR AND RELATED SURFACE EFFECTS. Fontell, A.; Arminen, E. (Univ. of Helsinki). Can. J. Phys., 47: 2405-14(Nov. 1, 1969).

The direct collection of Fe, Co, Ni, Cu, Zn, and Sn ions has been investigated in the energy range from about 10 eV to 110 keV in an electromagnetic isotope separator. At low energies the ions built up a layer on the surface of the graphite block used as a backing, while at high energies only a certain saturation value could be collected. For these ions the highest energies at which the building-up of a layer was observed were 1.5, 1.0, 0.8, 0.3, 0.3, and 0.45 keV, respectively. In the building-up region the efficiency of the collection process and the sticking probability of ions as a function of energy were measured. From these the self-sputtering ratios were calculated. In the saturation region the amounts of material collected were measured and the ranges of ions in graphite backings saturated with metal atoms were calculated theoretically. This calculation gives an estimate of the metal atom concentrations in the graphite, which in turn determines the sputtering ratio of carbon. (auth) (Canada)

387 EUROPEAN URANIUM ENRICHMENT PLANT: COMPARISON BETWEEN THE EURATOM-REPORT AND THE FORATOM-REPORT. Bruechner, Hans-Joachim (AEG-Telefunken, Frankfurt am Main). At. Strom, 15: 151-4(Sept. 1969). (In German).

The development of a European uranium enrichment plant is discussed. A comparison is made of the EURATOM report and the FORATOM report especially in view of the expected cost of separative work in a European enrichment plant. (auth)

388 CONVERGENCE AND CONCENTRATION DEPENDENCE OF ISOTOPIC THERMAL DIFFUSION FACTOR. Laranjeira, M. F.; Cunha, M. Aurea; Fronteira E Silva, M. E. (Comissao de Estudos de Energia Nuclear, Lisboa, Portugal). Port. Phys., 5: 49-59(1968).

The convergence and the concentration dependence of the isotopic thermal diffusion factor is theoretically studied, on the basis of Lennard-Jones and exponential-six models. The concentration dependence is not negligible a priori for binary mixtures of light isotopes, and significant differences may be expected for α_T if one or other of the isotopes is present in tracer concentrations. In the majority of practical cases, the Kihara-Mason scheme of approximation provides better convergence and is therefore preferred. (auth)

389 CONCENTRATION DEPENDENCE OF THE ISOTOPIC THERMAL DIFFUSION FACTOR FOR MIXTURES ^3He–^4He AND H_2–D_2. Laranjeira, M. F.; Cunha, M. Aurea; Fronteira E Silva, M. E. (Comissao de Estudos de Energia Nuclear, Lisboa, Portugal). Port. Phys., 5: 61-70(1968).

Experimental data for mixtures of $^3He-^4He$ and H_2-D_2 have been interpreted by means of the isotopic approach for the thermal diffusion factor, including a concentration-dependent term. It is shown that for $^3He-^4He$ mixtures the approach is quite satisfactory, regarding the mass effect and the concentration dependence. For H_2-D_2 mixtures the mass coefficient $(m_1-m_2)/(m_1+m_2)$ is already too large and general expressions for α_T might be preferred. (auth)

390 ABSOLUTE DETERMINATION OF NEUTRON SOURCE STRENGTH IN THE GERMAN BOARD FOR METROLOGY AND GOODS TESTING. PART II. ABSOLUTE DETERMINATION BY ACTIVATION OF AN AQUEOUS SOLUTION OF MANGANESE SULFATE. Hochhaeuser, E.; Rothe, H.; Guehne, F. (Deutsches Amt fuer Messwesen und Warenpruefung, Berlin). Kernenergie, 12: 274-9(Aug. 1969). (In German).

After describing the measuring technique based on activation of gold foils and the standardization of the RaBe(α,n) source HP-322 the so-called manganese bath technique is described. The moderator, which thermalizes the neutrons, consists of an aqueous solution of manganese sulfate. The absolute activity of the ^{56}Mn formed in the solution by neutron capture is measured by a scintillation counter. The calibration of the counter for ^{56}Mn absolute disintegration rate is based on the absolute measurement of the activity by using a $4\pi\beta$-counter. A detailed description of the activation equipment and of the activity measuring devices as well as an exemplification of the necessary corrections and of the measuring process in the light of standardization of the same HP-322 source is given. With this technique the source strength was found to be $Q = (5.56 \pm 0.10) \times 10^6\ s^{-1}$. (auth)

391 UNDERWATER POWER SOURCES. Espig, H. R. Underwater Sci. Technol. J., 1: 29-32(June 1969).

Isotopic thermoelectric generators are considered as an important type of underwater power source. For long unattended operation, thermoelectric generators combined with an isotope heat source are the lightest and most reliable available power sources. These systems, which have no moving parts, have been in continuous operation for periods of up to 10 yr and can be operated at any depths without loss in performance or reliability. Thermal power is usually obtained from the decay of ^{90}Sr, which is used in a highly insoluble form (ceramic strontium titanate) sealed in double-walled webbed Hastelloy cans for safety. Germanium and lead-telluride thermoelectric modules are used to convert the thermal output into dc electrical power, the modules being arranged in series/parallel for maximum reliability. Isotopic thermoelectric generators are available in a variety of designs, with power outputs of from a few milliwatts to 200 W. The equipment design must allow for the change in activity of the radioisotope with time, since the half-life of ^{90}Sr is 28 yr, causing a loss in output of 2.5%/yr. The overall system efficiency is about 2.5%, the waste heat usually being used to keep the associated equipment warm. The thermoelectric modules can be maintained or replaced if necessary without a hot cell, a heat pump being used to control the isotope temperature during the maintenance operations. Such isotopic generators can provide power in submerged buoys, for cable repeaters, and for valves on remote oil and gas wells. Sealed nickel-cadmium batteries are used in parallel with the generators where high peak loads occur. Capital costs are between 3000 and £25,000, with a fuel cost of £15/W, and overall operating costs are quoted in 2.2 pence W/hr. The major advantages are the high degree of reliability and lack of maintenance, but use is limited to continuously operating equipment with a well-defined load cycle, since they cannot be shut down or operated on part load. (BBB)

392 AEROSPACE RESEARCH AND DEVELOPMENT IN THE U. S. GOVERNMENT. 7. SECONDARY POWER. Zwick, Eugene B. Space/Aeronaut., 52: 143-8(July 1969).

Various secondary power systems for space applications are reviewed. As yet, only 4 types, with a maximum output of just a few kilowatts, have actually been operated in space: solar arrays, fuel cells, isotope thermoelectric systems, and batteries. Other systems have been flown experimentally, such as the Snap 10A reactor system, but it may be another 10 yr before a Snap 8 is flight-rated. Five isotopes are currently being considered for energizing various thermal power converters with outputs of up to 25 kW: ^{238}Pu, ^{244}Cm, ^{210}Po, ^{90}Sr, and ^{60}Co. Because ^{238}Pu and ^{244}Cm are α emitters and do not, in general, require shielding for biological reasons, the greatest design effort is being expended on increasing the operating temperatures of fuel blocks using these isotopes. These blocks are intended for advanced thermionic and closed-cycle systems requiring up to 3500°F. A current AEC program calls for the qualification, by the end of 1969, of a ^{238}Pu fuel block and compatible refractory container materials for operation at a surface temperature of 1780°F. For ^{244}Cm packaging techniques are not as well known, but a ^{244}Cm source is expected to qualify at 3000°F by 1972. The thermoelectric Snap 29 system, operating at 1700°F, uses ^{210}Po, another α emitter. However, ^{210}Po has a half-life of only 0.38 yr, limiting this converter to 90-day missions. Packaging studies of the β and γ emitters ^{90}Sr and ^{60}Co so far have been done only for relatively low operating temperatures. This design effort, however, may be strengthened if a need arises for a number of isotope systems, for the α emitters are expensive and available only in limited quantities. It appears, for example, that all the ^{238}Pu that could be made available in 1972 would supply only 25 kW of power during that year, while there would be enough ^{90}Sr to supply about 70 kW. The 35-kW nuclear reactor developed for Snap 8 is described, and mention is made of materials and component designs for advanced reactors using ceramic fuels, such as UO_2 and PuO_2, to produce temperatures of 2000 to 4000°F and up to several megawatts of power in combination with alkali-Rankine and thermionic converters. (BBB)

Materials Testing

Refer also to abstracts 436, 455, 456, 460, 474, 476, 1063, and 2044.

393 (SC-DR-69-65) SNAP-27 SHOCK OVERPRESSURE TEST (SHOCK TUBE FACILITY). Berry, R. E. (Sandia Labs., Albuquerque, N. Mex.). July 1969. 124p. Dep. CFSTI.

The SNAP-27 was subjected to an explosive shock tube test simulating the shock overpressure resulting from a near maximum explosive abort of the S-IVB stage of the Saturn V launch vehicle. This test demonstrated that the beryllium secondary thermal shield and fuel capsule assembly can withstand the simulated environment without fuel release. (auth)

394 QUALITY TESTS ON FUEL ELEMENT CLADDING WITH ULTRASONICS. Krohm, Georg (Nuklear-Chemie und -Metallurgie GmbH, Wolfgang, Ger.). At. Strom, 15: 128-30(July-Aug. 1969). (In German).

The very high requirements as regards the cladding quality of fuel elements in nuclear power stations necessitate exact testing methods of the specified characteristics. For nondestructive tests of the metal to be free of cracks inside and outside and without inclusions the method using ultrasonics has proved to be quite suitable. Ultrasonics can also be used for testing the can wall thickness. (auth)

395 STUDIES ON EMBRITTLEMENT BY HEATING HISTORY DURING PRODUCTION AND RADIOGRAPHIC INSPECTION OF NOZZLE PART IN REACTOR PRESSURE VESSELS. Yosetsu Gijutsu, 17: No. 4, 81-7(Apr. 1969). (In Japanese).

Radiographic inspection of pressure vessel nozzle parts was conducted using 15 MeV betatron, 5 MeV linear accelerator, ^{60}Co and ^{137}Cs γ equipment. The effects of heat treatments on brittle fracture, elongation, ductile fracture, and fatigue characteristics of A302B steel cylindrical vessels were determined. Characteristics such as brittle fracture, strain controlled low-cycle fatigue, uniform elongation, and fracture of vessel due to internal pressure deteriorated during hot press treatment, and recovered from this inferior quality during stress relief annealing at 630°C. The fatigue strength was greatest in the material subjected to hot press treatment. The results of these studies are satisfactory for application to production and radiographic inspection of pressure vessels. (NSA of Japan)

396 REVIEW: RADIOGRAPHY WITH NEUTRONS. Hawkesworth, M. R.; Walker, J. (Univ. of Birmingham, Eng.). J. Mater. Sci., 4: 817-35(Sept. 1969).

The technique of using neutron beams for radiographic purposes, a relatively new method of nondestructive testing, is reviewed. The various sources of neutrons and image recorders which may be used are discussed with particular emphasis on photographic recorders. Problems in which neutron radiography is expected to show advantages over conventional radiography such as in nuclear reactor technology are outlined, and some results are presented. (auth) (UK)

397 LEAK TESTING WELDED VESSELS. Roehrs, Robert J. (McDonnell Douglas Corp., St. Louis). Mater. Eval., 27: 205-14; 219(Oct. 1969).

Methods discussed for the leak testing of welded vessels include hydrostatic, pneumatic, visual, color contrast dye-penetrant, fluorescent, smoke-bomb, sound-level, displacement, chemical reaction, bubble, infrared, thermal conductivity, halogen diode, ionization gage, helium mass spectrometer, radioisotope, and high-vacuum testing. The methods described can often be used in determining leakage into, or out of, numerous objects, such as electronic components, aerospace hardwater, piping, and pressure and vacuum systems. (J.C.W.)

398 UTILIZATION OF SMALL ACCELERATOR NEUTRON GENERATORS FOR NEUTRON RADIOGRAPHY. Breynat, Genevieve; Dubus, M. M. (CEN, Grenoble, France). Mater. Eval., 27: 220-4(Oct. 1969).

Some neutron radiography tests were carried out with small accelerator neutron generators. The first experiments determined the best conditions of fast neutron thermalization. With the moderator assembly, neutron radiography images were obtained by the methods used with reactors (transfer method). The direct exposure method was also usable, either with gadolinium converter or with scintillators. Some other nondestructive testing possibilities with fast neutrons are being studied. (auth)

399 NEUTRON RADIOGRAPHY WITH A COCKROFT–WALTON ACCELERATOR. Iddings, Frank A.; Bostrom, Norman A. (Accelerators, Inc., Austin, Tex.). Mater. Eval., 27: 215-19(Oct. 1969).

High beam current particle accelerators can be used to produce neutron radiographs of acceptable quality for some applications. The radiographs are obtained in exposure times as low as several seconds to as long as 30 minutes. The radiographs show adequate resolution for small electronics and manufactured parts. The accelerator offers simplicity, easy operation, low cost and availability of local installation. (auth)

400 CONTROL SYSTEMS OF GAMMA-RADIOGRAPHY MACHINES WITH LONG-DISTANCE PROJECTION OF RADIATION SOURCE. Hlebowicz, J. (Electrotechnical Research Inst., Warsaw). Pomiary, Automat., Kontr., 14: 372-3(1968). (In Polish).

Control systems for gamma-radiography devices with long-distance projection of radiation sources are described. A review was made of some more interesting Polish and foreign designs. (auth) (NSA of Poland)

401 RADIOGRAPHIC APPARATUS. Catchpole, James William; Seward, George Alfred (to C. S. Products). British Patent 1,165,340. Sept. 24, 1969. Filed Feb. 12, 1968.

Equipment for the storage and use of radioactive source material, particularly for the radiographic examination of materials, is described. Improvements claimed over conventional apparatus include greater safety for the operator and greater flexibility in use. The apparatus described comprises a body constructed of radiation shielding material having a bore communicating with an exposure aperture in the body, and a handle extending into the bore; the inner end of the handle serves as a carrier for the radioactive source material. The handle is movable relative to the body so as to give exposed and shielded positions, and is lockable to the body. The handle includes a rod of shielding material which is a sliding fit in the bore, whereby an operator holding the handle is shielded from radioactivity. The shielding material may be depleted uranium. The handle may be arranged so as to be lockable selectively in any one of a number of positions in each of which the source is exposed to differing extents. A castle may be provided to receive the body part and arranged so as to be releasably coupled to the handle by a bayonet coupling or couplings, the arrangement being such that the selection of a particular pair of bayonet joints determines the extent of exposure of the source when the handle is locked in position. A container having a block of shielding material with a blind bore may be provided to receive the body of the device. (UK)

402 APPLICATIONS OF NEUTRON RADIOGRAPHY IN FAST REACTOR FUEL DEVELOPMENT. Haskins, J. J.; Jaklevick, J. F.; Wilkinson, C. D. (General Electric Co., Pleasanton, Calif.). pp 218-21 of Proceedings of the 16th Conference on Remote Systems Technology. Hinsdale, Ill., American Nuclear Society, Inc., 1969.

From Remote Handling and Examination in the Fast Reactor Field Meeting, Idaho Falls, Idaho. See CONF-690305.

The use of neutron radiography for nondestructive examination of irradiated nuclear fuel has been cited previously. This method of nondestructive examination of irradiated fuel elements and capsules is now in routine use in support of programs for development of fast reactor fuel. Neutron radiographic inspection of fuel elements and capsules is used to determine the condition of cladding and other non-fuel hardware, as well as the condition of the fuel. The fuel is examined for such characteristics as cracks, pellet interfaces, voids, enrichment variations, proper location, etc. Comparison of neutron radiograph images taken before, during, and after completion of the irradiation program yields maximum nondestructive examination information. The facilities and methods used for neutron radiography inspection of irradiated fuel elements and capsules are discussed. The type and amount of information that can be obtained are demonstrated. (auth)

403 RADIOGRAPHIC INSPECTION OF IRRADIATED FUEL ELEMENTS USING THE 22-MeV BETATRON. Elliott, D. E.; Torbert, J. F. (Los Alamos Scientific Lab., N. Mex.). pp 222-7 of Proceedings of the 16th Conference on Remote Systems Technology. Hinsdale, Ill., American Nuclear Society, Inc., 1969.

From Remote Handling and Examination in the Fast Reactor Field Meeting, Idaho Falls, Idaho. See CONF-690305.

Radiographic techniques for the inspection of radioactive reactor fuel elements have been developed and applied over the past six years. A 22-MeV betatron has proved to be an excellent source for this radiography. It has the necessary small emitting surface, radiation output, and radiation energy. This radiography has been valuable not only in providing information about the condition of the assembly but also as a guide for its subsequent destructive examination. Use of the procedure produces better radiographic resolution than has been developed in neutron radiography but cannot be used on assemblies with as high gamma activity. (auth)

404 EXAMINATION OF FAST REACTOR FUEL ELEMENTS WITH A Ge(Li) ANTICOINCIDENCE GAMMA-RAY SPECTROMETER. Holm, Dale M.; Sanders, W. Mort; Parker, Jack L.; Cowan, Helen D. (Los Alamos Scientific Lab., N. Mex.). pp 228-42 of Proceedings of the 16th Conference on Remote Systems Technology. Hinsdale, Ill., American Nuclear Society, Inc., 1969.

From Remote Handling and Examination in the Fast Reactor Field Meeting, Idaho Falls, Idaho. See CONF-690305.

The distributions of individual isotopes in irradiated fast reactor fuel elements has been measured by gamma scanning with a Ge(Li) anticoincidence detector system. Complex gamma-ray spectra from known regions on the samples are analyzed on a digital computer to determine the areas of the individual full-energy peaks. The peak areas from each isotope are plotted as a function of position on the sample. Test fuel for a liquid-plutonium reactor, EBR-II driver fuel, and a disk sample from an oxide fast reactor test fuel were examined. Large differences in the distributions were observed in the two test fuels, but no significant abnormalities were observed in the EBR-II driver fuel. Interesting characteristics of fuel element performance can be determined by interpreting the distributions of the various fission and activation products. (auth)

405 A SYSTEM FOR BIAXIAL STRESS TESTING OF IRRADIATED FUEL CLADDING IN LIQUID-METAL OR GASEOUS ENVIRONMENTS. Barker, Richard W. (Battelle-Northwest, Richland, Wash.). pp 261-6 of Proceedings of the 16th Conference on Remote Systems Technology. Hinsdale, Ill., American Nuclear Society, Inc., 1969.

From Remote Handling and Examination in the Fast Reactor Field Meeting, Idaho Falls, Idaho. See CONF-690305.

A system is described which is designed to measure the stress-to-rupture properties of irradiated fuel cladding material under biaxial stress conditions. Tests can be performed at temperatures from 427 to 816°C in sodium and in inert gas with rupture times ranging from 10^{-1} to 10^{4} hr. The testing complex consists of a series of low-cost test rigs which contain the specimen and test environment. Forty-eight concurrent tests may be conducted in six furnaces. The stress on each of the test specimens is remotely monitored by a pressure transducer. All experimental variables such as temperature, pressure, and time are recorded by an automatic data logging system. Experimental data are generated to describe the effects of stress on rupture life and ductility (and average creep rate), and the effect of fluence at the various test temperatures. (auth)

406 ULTRASONIC PROPERTIES MEASUREMENTS ON IRRADIATED STRUCTURAL MATERIALS. Hunter, D. O. (Battelle-Northwest, Richland, Wash.). pp 269-75 of Proceedings of the 16th Conference on Remote Systems Technology. Hinsdale, Ill., American Nuclear Society, Inc., 1969.

From Remote Handling and Examination in the Fast Reactor Field Meeting, Idaho Falls, Idaho. See CONF-690305.

Remote ultrasonic measurements have been made on irradiated steel. Results on specimens irradiated at temperatures <350°F indicate a fluence dependency. Results for some 304 specimens irradiated at temperatures between 700 and 1000°F also indicate a fluence dependency but must be considered preliminary. Ultrasonic methods appear potentially useful for assessment of radiation damage in reactor surveillance specimens. Additional usefulness may develop as a supplementary tool in assessing the nature of radiation damage and recovery in steel specimens. (auth)

407 SOME FUTURE POTENTIALITIES OF NEUTRON RADIOGRAPHY. Barton, John P. (Argonne National Lab., Ill.); Berger, Harold; Cutforth, Darrel C. pp 276-88 of Proceedings of the 16th Conference on Remote Systems Technology. Hinsdale, Ill., American Nuclear Society, Inc., 1969.

From Remote Handling and Examination in the Fast Reactor Field Meeting, Idaho Falls, Idaho. See CONF-690305.

The future development possibilities for radiography using neutrons are considered. Expansion in both technique development and application activity has been considerable over the past year or two, and this augers well for the future. A large number of promising avenues await exploration. Advances may be anticipated in neutron radiography using non reactor sources (accelerators and radioactive sources) as well as reactor sources. Useful developments may also be anticipated in neutron detection methods for radiography. In addition to thermal-neutron radiography, the use of cold neutrons, resonance-energy neutrons, epithermal and fast neutrons all have foreseeable advantages. (auth)

408 THE POTENTIAL OF HOLOGRAPHY FOR IRRADIATED MATERIALS EXAMINATION. Brenden, B. B.; Hildebrand, B. P. (Battelle-Northwest, Richland, Wash.). pp 289-94 of Proceedings of the 16th Conference on Remote Systems Technology. Hinsdale, Ill., American Nuclear Society, Inc., 1969.

From Remote Handling and Examination in the Fast Reactor Field Meeting, Idaho Falls, Idaho. See CONF-690305.

Holography is an imaging technique that permits interferometric comparisons of a diffusely reflecting object of complex configuration with the same object under a different stress loading for purposes of studying the distribution of strain. Holography has also been applied with considerable success to acoustical imaging. The progress of stress-corrosion cracking can be studied by application of a combination of holographic interferometry, acoustical holography, and acoustical emission techniques. It also seems likely that holographic interferometry will become a powerful tool for tensile testing. (auth)

409 CHARACTERIZING COMPOSITIONS OF IRRADIATED FUEL AT OPERATING TEMPERATURES: FUTURE NEEDS. Waterbury, Glenn R.; Metz, Charles F. (Los Alamos Scientific Lab., N. Mex.). pp 301-6 of Proceedings of the 16th Conference on Remote Systems Technology. Hinsdale, Ill., American Nuclear Society, Inc., 1969.

From Remote Handling and Examination in the Fast Reactor Field Meeting, Idaho Falls, Idaho. See CONF-690305.

The capabilities to characterize the compositions of irradiated fuels are extensive and have not lagged very far behind the needs. Future requirements must be defined to stimulate work that will provide the necessary new analytical techniques and methods. One real challenge is the examination and analysis of irradiated fuels at reactor operating temperatures. This and other developing problem areas are discussed to provoke consideration of future needs. (auth)

Protective Structures

Refer also to abstracts 337, 344, and 1112.

410 (ORNL-4413(Pt.1)) CIVIL DEFENSE RESEARCH PROJECT. Annual Progress Report, March 1968-March 1969. (Oak Ridge National Lab., Tenn.). Oct. 1969. Contract W-7405-eng-26. 117p. Dep. CFSTI.

One year's work on the Civil Defense Research Project is reported in five major sections: urban research; civil defense systems analysis; social aspects of civil defense; weapons effects; and post-attack recovery. The results of literature searches and both experimental and theoretical research in each of these sections is reported. (L.C.L.)

411 OPERATION SURVIVAL. Foss, J. W.; Mayo, R. W. (Bell Telephone Labs., Murray Hill, N. J.). Electron. World, 82: 41-3(Aug. 1969).

Ways of hardening communication systems to withstand a thermonuclear attack are considered. The plan for survival makes use of the alternate routing flexibility which already exists in the network. Some components of conventional telephone plants are sensitive to the effects of nuclear explosions even at considerable distances. Damage would be caused mainly by peak overpressure and a strong electromagnetic signal, commonly called the electromagnetic pulse (EMP). Two basic techniques are used to protect the communications network: either structures and equipment are initially designed or modified to tolerate specific assumed conditions, or sensitive elements in the system are shielded or isolated to reduce specific effects to tolerable levels. Typical examples of hardened plants in the Bell System are the L-3 and L-4 transcontinental coaxial-cable systems. Buildings for these systems are designed to withstand overpressure of 10 or 50 psi. The coaxial-cable systems have manned, underground main stations located at 12-mile to 160-mile intervals along the entire route. Designs for protection of electronic equipment in main and power-feed buildings from the effects of EMP are described. Features of underground buildings for the network are noted. New designs for resistant microwave antennas are described. The network should provide the United States with communications during any natural disaster and even in a nuclear attack. (BBB)

Radioactive Material Handling

Refer also to abstracts 347, 1067, and 1068.

412 (AERE-R-6115) A LEAD-SHIELDED CELL FOR THE ANALYSIS OF α, β, γ ACTIVE MATERIALS. Milner, G. W. C.; Wood, A. J.; Fudge, A. J. (Atomic Energy Research Establishment, Harwell (England)). July 1969. 22p. Dep. CFSTI (U. S. Sales Only). UK 5s. 6d.

A cell with 4 in. thick lead walls was built for analytical work in support of the reactor development programs. A feature of this cell is that it consists of two separate interconnected units. One unit is fixed and is available for nondestructive analysis, sample preparation, posting operations, and sample storage. The second unit contains an interchangeable fibre glass box for chemical work. Details are given of the construction of the cell and of the permanently installed equipment. Typical cell operations are described. (auth) (UK)

413 (ARH-SA-41) WASTE ENCAPSULATION AND STORAGE FACILITIES AT HANFORD. Caudill, H. L.; LaRiviere, J. R.; Shaw, H. P. (Atlantic Richfield Hanford Co., Richland, Wash.). [nd]. 25p. (SM-125/61; CONF-691008-2). Dep. CFSTI.

From Symposium on Radiation Safety Problems in the Design and Operation of Hot Facilities, Saclay, France.

The design and operation of a facility for encapsulating and storing ^{137}Cs and ^{90}Sr which have been separated from wastes stored at Hanford are described. This plant has two processing sections, a hot cell facility for encapsulation and a capsule storage facility. The encapsulation facility has cells for waste handling, strontium processing, cesium processing, decontamination, and packaging and loadout. Drawings and process diagrams of the facilities are presented. (L.C.L.)

414 (ARH-SA-52) SAFE MANAGEMENT OF RADIOACTIVE WASTES. Harvey, Robert W. (Atlantic Richfield Hanford Co., Richland, Wash.). [nd]. 14p. Dep. CFSTI.

The procedures used at the fuel reprocessing plants at Hanford, Washington, for the safe management of radioactive wastes are described. These included stack disposal of gaseous wastes, burial of solid waste materials, and both liquid waste disposal by percolation through soils and the underground tank storage of liquid wastes which will subsequently be reprocessed. (L.C.L.)

415 (ORNL-4422, pp 322-4) SAFETY STUDIES OF FUEL TRANSPORT. (Oak Ridge National Lab., Tenn.).

A program was organized in early 1966 to identify and resolve problems involving the transport of irradiated fuel elements from a reactor to a reprocessing site and to develop an Irradiated Fuel Shipping Cask Guide. The Guide was completed and is available as ORNL-TM-2410. It establishes suitable engineering standards for the design, fabrication, and inspection of irradiated fuel shipping casks by providing information on structural integrity, shielding, heat transfer, criticality, and materials of construction. A considerable amount of emphasis is placed on quality control during the fabrication of a cask. The Guide is presently being revised to incorporate newly developed data and comments from recipients of the report. (auth)

416 (ORNL-tr-1080) SMALL-SCALE CLARIFICATION UNIT FOR RADIOACTIVE SEWAGE. Schulze-Rettmer, R.; Rattay, K. H. Translated by Kenneth S. Warren (Oak Ridge National Lab., Tenn.), from Atompraxis, 11: 320-2(1965). 4p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 19: 38288.

417 (WCAP-3896-1) EVALUATION OF FUEL ACCOUNTABILITY METHODS APPLIED TO YANKEE FUEL. Nodvik, R. J.; Guthrie, C. E.; Corbett, J. A. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). June 1968. Contract AT-(30-1)-3896. 156p. Dep. CFSTI.

Two basic methods of fuel accountability were evaluated as applied to 50 tonnes of fuel discharged from Yankee Cores I, II, III, and IV. The volumetric method employed both mass-spectrometric analysis for uranium and plutonium isotopic abundances and for concentration of uranium and plutonium, and accurate measurement of the volume of dissolver solution in the assay tank. The weight of each uranium and plutonium isotope is then calculated from the analyses and temperature-corrected solution volume. The gravimetric method employs: mass-spectrometric analysis for uranium and plutonium isotopic abundances and for the Pu/U ratio; a computer calculation to determine uranium-238 depletion based on a heavy element balance and fuel nuclear parameters; and manufacturer's records of initial fuel weight and enrichment. The weight of each uranium and plutonium isotope is then calculated based on its isotopic ratio to uranium-238 from the analyses and the calculated uranium-238 discharge. Based on batch samples the two methods are in statistical agreement where an integral number of precisely identified fuel assemblies is included in each batch. For the three campaigns and the total processed, where there is some uncertainty as to the identity and quantity of fuel in each individual accountability batch, there are some minor statis-

tical differences between the two methods. On the total processed the quoted uncertainty for the volumetric method was ±0.3 percent for uranium and ±0.5 percent for plutonium compared to an estimated ±0.13 percent for uranium ±0.3 percent for plutonium for the gravimetric method. The gravimetric method results in a determination of fuel burnup which is in statistical agreement with calorimetric data. Difficulties were encountered in using composite samples for accountability due to differences in analyses from independent laboratories and an apparent error in the composite for one of the three campaigns. (auth)

418 PLUGGING OF LEAKS IN RADIUM CONTAINERS. Rozenfeld, M. L.; Mason, E. W. (Univ. of Chicago). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 105: 689-97 (Mar. 1969).

It was assumed that a hole in a radium container was formed and that it enlarged as the solder joint deteriorated. Another assumption investigated was that holes left in the solder joint during the manufacturing process are later plugged by washing or plating solutions. Immediate radon leak testing fails to detect the defects, but over the years the holes are unplugged by drying or re-immersions in washing or sterilizing solutions. Heating can be used to uncover the leaks, but this procedure should be done by the manufacturer. If new radium containers are purchased, the order should specify that the containers be heated to 150°C overnight before the final leak test. (J.C.W.)

419 CIVIL LIABILITY AND SAFETY IN MARITIME TRANSPORT OF NUCLEAR MATERIALS. de los Santos Lasurtegui, Alfonso (Junta de Energia Nuclear, Madrid). Energ. Nucl. (Madrid), 13: 57-66 (Jan.-Feb. 1969). (In Spanish).

Upon the initiative of the European Atomic Energy Commission, 18 representatives of international organizations concerned with atomic energy and maritime transport convened in Monaco in October 1968 to study problems of transport of fissionable and nuclear materials by sea-going vessels. Delegates from 22 countries participated in this international symposium, which was concerned with problems of transportation and security and legal problems. The representative of the International Maritime Commission stated that it would be unwise to hinder development of world traffic by strict adherence to existing regulations, oblivious to recent technical developments, while ignoring new methods to ensure greater security of lives and goods at sea. It was concurred that the nature of nuclear danger on ships at sea must be clearly conceived; the dimensions of possible damage comprehended; and its coverage by insurance regulated. It was also resolved that existing laws and conventions must be followed as far as possible, but concerted efforts should be made to modify them in accordance with technical means and economic needs. It will be necessary to bring the national laws of certain countries in line with international regulations. In conclusion it was suggested that work be carried out for unification of all security measures and that a reunion of all parties concerned in the shipment of nuclear materials be brought about to make concrete proposals for such unification. (F.J.W.)

420 PROCEEDINGS OF THE TENTH ANNUAL MEETING OF THE INSTITUTE OF NUCLEAR MATERIALS MANAGEMENT, LAS VEGAS, NEVADA, APRIL 28–30, 1969. Columbus, Ohio, Institute of Nuclear Materials Management, 1969. 490p. $7.50. (CONF-690411).

Thirty-two papers presented at the tenth annual meeting of the Institute of Nuclear Materials Management held at Las Vegas, Nevada on April 28 to 30, 1969 are presented. Separate abstracts were prepared for each. (L.C.L.)

For abstracts of individual papers see: 347 and 421–451.

421 SPECIFICATION PACKAGINGS: PROGRESS AND POTENTIAL. Blackburn, R. W. (Atomic Energy Control Board, Ottawa). pp 25-38 of Proceedings of the Tenth Annual Meeting of the Institute of Nuclear Materials Management, Las Vegas, Nevada, April 28–30, 1969. Columbus, Ohio, Institute of Nuclear Materials Management, 1969.

See CONF-690411.

Specific packagings, i.e., standardized packages which meet rational requirements for the safe shipment of radioactive materials, are discussed in terms of the progress that has been made in developing internationally uniform shipping safety specifications, in promoting the use of standardized design packages which meet these specifications, and in designating a recognized standards authority which would work on certifying packaging designs and materials which can be used for the safe, economical, and efficient transportation of nuclear materials. (L.C.L.)

422 NUCLEAR FUEL FINANCING. Johnson, E. R.; Gammill, A. M. (E. R. Johnson Associates, Washington, D. C.). pp 39-54 of Proceedings of the Tenth Annual Meeting of the Institute of Nuclear Materials Management, Las Vegas, Nevada, April 28–30, 1969. Columbus, Ohio, Institute of Nuclear Materials Management, 1969.

See CONF-690411.

The problem of financing or leasing the large quantities of nuclear materials which will be needed in the future for electricity-generating nuclear power plants is discussed by predicting fuel requirements through 1980, by examining the cost of processing and reprocessing fuels, by reviewing the regulations for ownership of nuclear materials, and by citing financing and leasing methods. (L.C.L.)

423 PURDUE NUCLEAR FUEL MANAGEMENT COURSE. Fulford, P. J. (Purdue Univ., Lafayette, Ind.). pp 55-60 of Proceedings of the Tenth Annual Meeting of the Institute of Nuclear Materials Management, Las Vegas, Nevada, April 28–30, 1969. Columbus, Ohio, Institute of Nuclear Materials Management, 1969.

See CONF-690411.

A Purdue University course in nuclear fuel management is described. The 20-lecture program was intended for both financial and technical personnel in the electric utility industry and treated in detail the complete fuel cycle from mining to storage of radioactive wastes. (L.C.L.)

424 PLUTONIUM WASTE ASSAY UTILIZING A LARGE VOLUME Ge(Li) DETECTOR. Deal, R. A.; Gettings, J. F.; James, D. B. (Nuclear Materials and Equipment Corp., Apollo, Pa.). pp 61-76 of Proceedings of the Tenth Annual Meeting of the Institute of Nuclear Materials Management, Las Vegas, Nevada, April 28–30, 1969. Columbus, Ohio, Institute of Nuclear Materials Management, 1969.

See CONF-690411.

The results of a limited study of the application of Ge(Li) gamma spectroscopy to the assay of PuO_2-contaminated waste are presented. The method is based on the use of commercially available instrumentation components, and requires only that waste packages be standardized within the plant. More important than establishing an assay method for PuO_2 in polyvinylchloride (PVC) waste, these results have been presented to highlight the feasibility of this approach to the assay of many forms of waste materials contaminated with many types of nuclear materials. By utilizing the other specific gamma activities and preparing appropriate standard curves, the technique can be applied to other forms of low-density waste, contaminated with metal or compounds of plutonium and uranium and their mixtures, with varying isotopic compositions. (auth)

425 IMPACT OF CRITICALITY SAFETY ON THE FABRICATION OF LMFBR FUEL. Brown, C. L. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. pp 77-88 of Proceedings of the Tenth Annual Meeting of the Institute of Nuclear Materials Management, Las Vegas, Nevada, April 28–30, 1969. Columbus, Ohio, Institute of Nuclear Materials Management, 1969.

See CONF-690411.

Criticality safety is one of the most important factors affecting the cost of fabricating fuel for the LMFBR program. The effects of criticality safety on the rate of LMFBR fuel fabrication were evaluated by comparing the fuel and safety requirements for the LMFBR with those of the BWR, PWR, and LWR. It was concluded that: LMFBR fuel fabrication will be most limited by criticality safety in operations involving solutions; criticality safety should not seriously limit dry operations; special controls will be necessary when handling subassemblies because fewer than ten will support a neutron chain reaction dry; and, from the standpoint of criticality safety, reasonably high competitive throughput rates should be possible for FBR fuel fabrication. (L.C.L.)

426 AUTOMATED DATA PROCESSING SYSTEM FOR SS MATERIAL CONTROL. Hazelton, L. D.; Dunn, D. A. (Dow Chemical Co., Golden, Colo.). pp 89-108 of Proceedings of the Tenth Annual Meeting of the Institute of Nuclear Materials Management, Las Vegas, Nevada, April 28–30, 1969. Columbus, Ohio, Institute of Nuclear Materials Management, 1969.

See CONF-690411.

Automated computerized SS Materials control systems are required to meet today's demand for timely information. The basic concepts of a fully automated SS Material control system in use at the Dow Chemical Company, Rocky Flats Division are described. Control program theory, how programs work, role of physical inventories, finding and correcting discrepancies, end products (information on a timely basis) and problems associated with design and implementation are covered. (auth)

427 PLUTONIUM FOR RECOVERY FROM SCRAP AT ATLANTIC RICHFIELD HANFORD COMPANY. Kuklinski, G. B.; Olson, R. E. (Atlantic Richfield Hanford Co., Richland, Wash.). pp 109-28 of Proceedings of the Tenth Annual Meeting of the

Institute of Nuclear Materials Management, Las Vegas, Nevada, April 28–30, 1969. Columbus, Ohio, Institute of Nuclear Materials Management, 1969.
See CONF-690411.

Operating procedures used to receive and convert plutonium-bearing scrap to high-purity plutonium nitrate product, and operating procedures used to measure or verify, repackage, and store the product are discussed. Shipper obligations or responsibilities and receiver handling methods are described. Nuclear Materials Management procedures pertinent to accounting, measurements, and inventory control are outlined. (auth)

428 MEASUREMENT OF PLUTONIUM IN PROCESS MATERIALS AND CONTAMINATED WASTE. Willoughby, O. H.; Cartwright, D. R. (Dow Chemical Co., Golden, Colo.). pp 129–42 of Proceedings of the Tenth Annual Meeting of the Institute of Nuclear Materials Management, Las Vegas, Nevada, April 28–30, 1969. Columbus, Ohio, Institute of Nuclear Materials Management, 1969.
See CONF-690411.

The continuing development of nondestructive, radiometric methods for assaying the amount of Pu in bulk quantities of process residues and waste is described. Each method uses the inherent radiation from the nuclear material as a basis for measurement. The first drum counter developed in 1964 is discussed in detail. It consisted of eight 30 in. halogen-quenched Geiger–Mueller detectors and 16 BFl_3 neutron detectors within a shielded cavity plus instrumentation for presenting the detected signals as measurements. The progressive development of more refined drum counters is described. Data from 325 measurements averaging about 80 g of Pu per measurement show an average bias of 5.1%. It is concluded that the successful measurement of process residues has been achieved. (L.C.L.)

429 CONTROLLING LARGE QUANTITIES OF PLUTONIUM FUEL. Beyer, N. S.; Perry, R. B.; Brandenburg, R. W.; Hurst, L. K. (Argonne National Lab., Ill.). pp 143–68 of Proceedings of the Tenth Annual Meeting of the Institute of Nuclear Materials Management, Las Vegas, Nevada, April 28–30, 1969. Columbus, Ohio, Institute of Nuclear Materials Management, 1969.
See CONF-690411.

The fuel for the Zero Power Plutonium Reactor (ZPPR) consists of an inventory of about 3,000 kg of Pu contained in approximately 12,000 fuel plates. Handling such a large inventory of Pu required the development of special control methods. An automated gamma measurement system developed to permit the nondestructive assay of the Pu is described, and its accuracy is evaluated by inventory verification. It is concluded that the gamma assaying method is economical, that its precision and accuracy approached that of the conventional method of sampling measurements by chemical and mass spectrometric techniques, that it has the distinction of "seeing" much larger samples than other methods, and that gamma assaying is not limited to Pu inventories, but can be used for large U inventories. (L.C.L.)

430 THREE KEY ASPECTS OF NUCLEAR MATERIALS MANAGEMENT. Donelson, J. G.; Klemens, R. W.; Samuelson, D. C. (Price Waterhouse and Co., Pittsburgh). pp 169–214 of Proceedings of the Tenth Annual Meeting of the Institute of Nuclear Materials Management, Las Vegas, Nevada, April 28–30, 1969. Columbus, Ohio, Institute of Nuclear Materials Management, 1969.
See CONF-690411.

Three aspects of nuclear materials management are presented. Inventory control is discussed in terms of the financial impact of inventory levels and what nuclear materials managers can do about this. Record-keeping methods are analyzed to show the who, how, and why of nuclear materials record–keeping systems. Finally, management information systems are discussed in relation to what the nuclear materials manager needs to know to achieve favorable financial results. (L.C.L.)

431 NUCLEAR MATERIALS MANAGEMENT: WHERE DO WE STAND. Ramey, James T. (Atomic Energy Commission, Washington, D. C.). pp 215–30 of Proceedings of the Tenth Annual Meeting of the Institute of Nuclear Materials Management, Las Vegas, Nevada, April 28–30, 1969. Columbus, Ohio, Institute of Nuclear Materials Management, 1969.
See CONF-690411.

The status of methods and safeguards used in nuclear materials management in the US is discussed briefly with emphasis on the roles of government and industry in nuclear materials management, growing uses of nuclear materials, and special problems involving uranium enrichment. (L.C.L.)

432 NUCLEAR NON-PROLIFERATION AND DISARMAMENT: THE NEXT TEN YEARS. Labowitz, Allan M. (Atomic Energy Commission, Washington, D. C.). pp 231–6 of Proceedings of the Tenth Annual Meeting of the Institute of Nuclear Materials Management, Las Vegas, Nevada, April 28–30, 1969. Columbus, Ohio, Institute of Nuclear Materials Management, 1969.
See CONF-690411.

Aspects of the nuclear Non-Proliferation Treaty are discussed, and the Treaty is related to future prospects for disarmament or arms control. (L.C.L.)

433 WHAT LIES AHEAD FOR NUCLEAR ENGINEERING EDUCATION: THE NEXT TEN YEARS. Weaver, Lynn E. (Univ. of Arizona, Tucson). pp 237–46 of Proceedings of the Tenth Annual Meeting of the Institute of Nuclear Materials Management, Las Vegas, Nevada, April 28–30, 1969. Columbus, Ohio, Institute of Nuclear Materials Management, 1969.
See CONF-690411.

Predictions on future developments in nuclear engineering education are made by stating past developments in the field since 1955 when information on reactor technology was first made public. It is predicted that due to the expense of nuclear engineering programs, there will be a consolidation of efforts resulting in 20 to 25 strong nuclear engineering degree programs; industry as well as government will have to support nuclear education and research; the need for water, power, and agricultural products will stimulate this participation; and the general public must be enlightened with factual nuclear energy information. (L.C.L.)

434 THE NUCLEAR LEGAL FIELD: THE NEXT TEN YEARS. Newman, Jack R. pp 247–58 of Proceedings of the Tenth Annual Meeting of the Institute of Nuclear Materials Management, Las Vegas, Nevada, April 28–30, 1969. Columbus, Ohio, Institute of Nuclear Materials Management, 1969.
See CONF-690411.

The legal aspects of nuclear energy, past and future, are discussed with reference to regulatory programs for safety, anti-trust considerations, and special problems connected with power plant operation, Plowshare applications, and fuel fabrication and reprocessing. (L.C.L.)

435 WHAT WILL THEY DO TO US NEXT. Brobst, William A. pp 259–70 of Proceedings of the Tenth Annual Meeting of the Institute of Nuclear Materials Management, Las Vegas, Nevada, April 28–30, 1969. Columbus, Ohio, Institute of Nuclear Materials Management, 1969.
See CONF-690411.

The development of regulations related to the transportation of radioactive materials is discussed. Information is presented on the inter-relationship of USAEC and IAEA regulations, packaging specifications, methods for handling transport permits, special requirements for the air transport of radioactive materials, and the possible theft of nuclear materials during transport. (L.C.L.)

436 THE ROLE OF THE NUCLEAR STANDARDS BOARD IN THE NUCLEAR INDUSTRY. Landis, J. W. (Gulf General Atomic Inc., San Diego, Calif.). pp 271–82 of Proceedings of the Tenth Annual Meeting of the Institute of Nuclear Materials Management, Las Vegas, Nevada, April 28–30, 1969. Columbus, Ohio, Institute of Nuclear Materials Management, 1969.
See CONF-690411.

The work of the Nuclear Standards Board of the USASI is described and includes committees which are concerned with: specification for and testing of nuclear materials used in nuclear applications; nuclear terminology; radiation terminology, radiation protection, radioactive materials transport and packaging, nuclear materials management, criticality safety, nuclear instruments, the design of nuclear equipment and facilities; and the location, construction, and operation of nuclear facilities. (L.C.L.)

437 EFFECT OF NUCLEAR STANDARDS ON THE NUCLEAR INDUSTRY. Graham, H. B. (Oak Ridge National Lab., Tenn.). pp 283–94 of Proceedings of the Tenth Annual Meeting of the Institute of Nuclear Materials Management, Las Vegas, Nevada, April 28–30, 1969. Columbus, Ohio, Institute of Nuclear Materials Management, 1969.
See CONF-690411.

The status of the USASI Nuclear Standards Committee work on developing standards for the nuclear industry is described. The responsibilities of each section of the committee are itemized, and the work complete and contemplated for each of these sections is discussed. (L.C.L.)

438 QUALIFICATION OF UMPIRE LABORATORIES FOR THE ANALYSIS OF URANIUM AND PLUTONIUM BEARING MATERIALS. Tingey, Fred H. (Idaho Nuclear Corp., Idaho Falls). pp 295–310 of Proceedings of the Tenth Annual Meeting

of the Institute of Nuclear Materials Management, Las Vegas, Nevada, April 28–30, 1969. Columbus, Ohio, Institute of Nuclear Materials Management, 1969.

See CONF-690411.

With the increased transfer of plutonium and uranium materials from the AEC to private industry and foreign countries, it became desirable to have US commercial and foreign government laboratories which could act as umpires in these transfer transactions, i.e., non-AEC laboratories qualified to precisely analyze uranium- and plutonium-bearing materials prepared in AEC laboratories. These materials include uranyl nitrate, uranium hexafluoride, plutonium nitrate, plutonium oxide, plutonium metal, ^{233}U-enriched uranyl nitrate, and uranium oxide. The analysis methods used for each material are described. To date the results show that 13 laboratories qualified for uranyl nitrate specifications, six laboratories for uranium hexafluoride specifications, and five for plutonium nitrate analyses. (L.C.L.)

439 CALCULATION OF INVENTORY UNCERTAINTY BY ESTIMATE SAMPLING. Lovett, James E. (Nuclear Materials and Equipment Corp., Apollo, Pa.). pp 311-24 of Proceedings of the Tenth Annual Meeting of the Institute of Nuclear Materials Management, Las Vegas, Nevada, April 28–30, 1969. Columbus, Ohio, Institute of Nuclear Materials Management, 1969.

See CONF-690411.

A method was developed which states in grams (or other physical units) the most probable value for the true inventory and the statistical confidence interval within which the true inventory of nuclear materials probably lies. Examples drawn from use of the method are discussed. The method is compared to traditional methods such as Gaussian propagation of error, and either attribute or variables inspection for acceptance, in order to show that each method basically answers a different question. Choice of any given method should be made primarily by consideration of the exact question to be answered. Generally referred to as "estimate sampling," the recommended method determines the average difference between the data used on the inventory and the "true" data (defined as the data resulting from a careful redetermination of selected items, using the best methods available). Stratification of the inventory is not necessary but generally is desirable. Sample sizes are not critical, and typically are no more than half the number of samples needed for good attribute sampling. (auth)

440 DETECTION AND ANALYSIS OF SHIPPER–RECEIVER DIFFERENCES. Coggshall, William L. (Stanford Research Inst., Calif.). pp 325-40 of Proceedings of the Tenth Annual Meeting of the Institute of Nuclear Materials Management, Las Vegas, Nevada, April 28–30, 1969. Columbus, Ohio, Institute of Nuclear Materials Management, 1969.

See CONF-690411.

The differences in measurements made by the receiver of radioactive material as compared with measurements made by the shipper are analyzed to determine if such differences are due to errors arising in the measurement processes, in the individual measurements, or in the sequence in which the measurements are made. (L.C.L.)

441 NUCLEAR SAFEGUARDS: CURRENT STATUS. Crowson, Delmar L. (Atomic Energy Commission, Washington, D. C.). pp 341-52 of Proceedings of the Tenth Annual Meeting of the Institute of Nuclear Materials Management, Las Vegas, Nevada, April 28–30, 1969. Columbus, Ohio, Institute of Nuclear Materials Management, 1969.

See CONF-690411.

Nuclear safeguards are described and include those associated with fuel cycle such as accountability procedures for determining inventories of radioactive materials, systems studies which identify where losses are experienced in a fuel cycle, inspection procedures, and nondestructive analysis methods for quantitatively measuring fuel losses. Also included are safeguards for preventing losses during the domestic and international transport of radioactive materials. (L.C.L.)

442 SURVEY OF NUCLEAR MATERIAL AND POSSIBLE MEASUREMENT TECHNIQUES. Higinbotham, W. A.; Court, A. (Brookhaven National Lab., Upton, N. Y.). pp 353-76 of Proceedings of the Tenth Annual Meeting of the Institute of Nuclear Materials Management, Las Vegas, Nevada, April 28–30, 1969. Columbus, Ohio, Institute of Nuclear Materials Management, 1969.

See CONF-690411.

The material accountability program for safeguards purposes depends on measurements which presently consist of destructive analyses, i.e., taking of samples which then are measured in an analytical laboratory. For inventory verification and special surveys some use is made of gamma ray analysis. The USAEC, the International Atomic Energy Agency and other institutions are now supporting development of a variety of passive measurement techniques which may supplement or replace the destructive measurements currently employed. The amounts and types of material which will exist during the next five years at various points in the nuclear fuel cycle in US privately owned facilities are described and what types of measurement techniques (destructive or nondestructive) may be applicable at each point are indicated. (auth)

443 A SAFEGUARDS TRAINING PROGRAM AT ARGONNE. Hyman, Herbert H.; Kanter, Manuel A. (Argonne National Lab., Ill.). pp 377-86 of Proceedings of the Tenth Annual Meeting of the Institute of Nuclear Materials Management, Las Vegas, Nevada, April 28–30, 1969. Columbus, Ohio, Institute of Nuclear Materials Management, 1969.

See CONF-690411.

A supervisory-level safeguards training program was conducted at Argonne National Laboratory from September 16 to December 3, 1968. The primary training of those enrolled was rather varied with accountants, statisticians, chemists, engineers, and business management disciplines all represented. The program included an introductory section in several basic disciplines, lecture and laboratory material on preparing and auditing records, analytical practice, and fuel cycle technology, and plant tours, seminars, library research and preparation of a paper and continuous interdisciplinary discussion. The logic used in planning the course is summarized, what was accomplished and what more could have been done are discussed. The second program is under way. It is segmented to permit greater homogeneity of students and shorter stays. It is quite clear that the growth of the nuclear industry over the next five years will require an increase in the demand for nuclear materials management personnel with a safeguards outlook. The role of the Argonne program in meeting this demand is outlined. (auth)

444 TOTAL SYSTEM MATERIAL CONTROL. Coggshall, William L. (Stanford Research Inst., Calif.). pp 387-98 of Proceedings of the Tenth Annual Meeting of the Institute of Nuclear Materials Management, Las Vegas, Nevada, April 28–30, 1969. Columbus, Ohio, Institute of Nuclear Materials Management, 1969.

See CONF-690411.

The development of expressions for computing the optimal estimates of amounts of nuclear materials in shipments, facility inventories, and total system inventory has demonstrated the usefulness of mathematical models and optimization techniques for assisting in the design and operation of materials safeguards systems of varying scopes. The results are based on a particular conceptualization of the system of facilities handling a particular material, making the results applicable only in theory to a system that can be thus idealized. However, the theory structures the overall materials control problem in a simple manner The usefulness of the theory can be tested by applying it, perhaps using a computer simulation model, to a subset of the network of facilities in the nuclear industry. (auth)

445 USE OF SEALS AS A SAFEGUARDS TOOL. Sastre, Cesar (Brookhaven National Lab., Upton, N. Y.). pp 399-410 of Proceedings of the Tenth Annual Meeting of the Institute of Nuclear Materials Management, Las Vegas, Nevada, April 28–30, 1969. Columbus, Ohio, Institute of Nuclear Materials Management, 1969.

See CONF-690411.

The possible uses of package seals for the prevention and detection of losses of nuclear materials during shipment are described. (L.C.L.)

446 THE DIVISION OF NUCLEAR MATERIALS SAFEGUARDS: THE FIRST YEAR. Wischow, Russell P. (Atomic Energy Commission, Washington, D. C.). pp 411-18 of Proceedings of the Tenth Annual Meeting of the Institute of Nuclear Materials Management, Las Vegas, Nevada, April 28–30, 1969. Columbus, Ohio, Institute of Nuclear Materials Management, 1969.

See CONF-690411.

The 1968 activities of the one-year-old USAEC Division of Nuclear Materials Safeguards in administering safeguards for all special nuclear materials are described. These activities include licensing and inspection of the 28 US facilities which are authorized to possess more than 5 kg of ^{235}U, ^{233}U, and Pu or any combination thereof in an unsealed configuration. Changes made in existing regulations are itemized. (L.C.L.)

447 ECONOMIC AND POLITICAL FACTORS IN SPECIAL NUCLEAR MATERIAL CONTROL OR IS OUR BEST GOOD ENOUGH. Kinderman, E. M. (Stanford Research Inst., Menlo Park, Calif.). pp 419-32 of Proceedings of the Tenth Annual Meeting of the Institute of Nuclear Materials Management, Las

Vegas, Nevada, April 28–30, 1969. Columbus, Ohio, Institute of Nuclear Materials Management, 1969.
See CONF-690411.

The economic and political factors which contribute to the emphasis on safeguards for preventing the loss of diversion of special nuclear materials are described. (L.C.L.)

448 SYSTEMS STUDIES FOR NUCLEAR MATERIALS SAFEGUARDS. Kouts, Herbert (Brookhaven National Lab., Upton, N. Y.). pp 433-40 of Proceedings of the Tenth Annual Meeting of the Institute of Nuclear Materials Management, Las Vegas, Nevada, April 28–30, 1969. Columbus, Ohio, Institute of Nuclear Materials Management, 1969.
See CONF-690411.

Systems studies for nuclear materials safeguards which assure no diversion of special nuclear materials involve analyzing the possible threats of intentional diversion and the capabilities for performing such diversions, methods for meeting such threats, and the cost of these methods. The procedures used in these particular systems studies are discussed. (L.C.L.)

449 ERROR ANALYSIS OF A SAFEGUARDS MEASUREMENT SYSTEM. Ong, L. D. Y.; Miraglia, F. J. Jr.; Smith, R. D. (Atomic Energy Commission, Washington, D. C.). pp 441-58 of Proceedings of the Tenth Annual Meeting of the Institute of Nuclear Materials Management, Las Vegas, Nevada, April 28–30, 1969. Columbus, Ohio, Institute of Nuclear Materials Management, 1969.
See CONF-690411.

The role of statistics in evaluating the effectiveness of nuclear materials safeguarding procedures is described. Statistics emphasize the importance of making numerous measurements, of making accurate measurements, and of booking the physical inventory, in order to minimize variations in the determination of materials unaccounted for (MUF). (L.C.L.)

450 AN INSPECTOR'S VIEW OF RECENT DEVELOPMENTS IN INTERNATIONAL SAFEGUARDS. Jennekens, J. H.; McManus, J. G. (Atomic Energy Control Board, Ottawa). pp 459-70 of Proceedings of the Tenth Annual Meeting of the Institute of Nuclear Materials Management, Las Vegas, Nevada, April 28–30, 1969. Columbus, Ohio, Institute of Nuclear Materials Management, 1969.
See CONF-690411.

The significance of the international safeguards system was magnified when, in July 1968, nations with only internal (national) nuclear programs and no nuclear weapons signed the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) along with nations with nuclear weapons programs. The effect of this treaty signing on the world-wide implementation of international safeguards, i.e., programs to prevent the diversion of nuclear materials into nuclear weapons, is discussed with reference to the role of the human safeguards inspector, safeguards instrumentation, the economics of existing systems and of research and development for improved systems, and how political developments in Euratom countries affect their safeguards systems. (L.C.L.)

451 SAFEGUARDS DURING TRANSPORTATION: A SHIPPER'S VIEWS. Edlow, Samuel. pp 471-84 of Proceedings of the Tenth Annual Meeting of the Institute of Nuclear Materials Management, Las Vegas, Nevada, April 28–30, 1969. Columbus, Ohio, Institute of Nuclear Materials Management, 1969.
See CONF-690411.

The environment of the transportation industry is examined and found to be one of incompetence and criminality. This affects the safeguards systems needed during the shipment of nuclear materials. The enactment of regulations 10 CFR for this purpose is evaluated as ineffective and insufficient to meet the need for meaningful, realistic safeguards with current transportation conditions. Recommendations are made for strengthening these regulations and for verifying the location of nuclear materials during transit. (L.C.L.)

452 IRRADIATING APPARATUS. Kirkpatrick, W. W.; Masefield, J. (to Atomic Energy of Canada Ltd.). Canadian Patent 811,240. Apr. 22, 1969.

The apparatus described is operated by remote control. It consists of a housing of shielding material defining an irradiating chamber for the sample, several guide tubes within the housing located in a cylindrical array around the chamber, a radioactive source in each guide tube and movable by fluid pressure from a position isolated from the sample in the chamber to a working position for irradiation, and a series of individually operable, fluid-pressure-operated assemblies. Each assembly is connected to an individual guide tube and operates to move the respective source in the guide tube from the isolated position to the working position. At least one of the fluid-pressure-operated assemblies is connected to a plurality of guide tubes. (F.S.A.)

453 SAFETY REGULATIONS CONCERNING NUCLEAR TRANSPORTATION. Swindell, Gerald E. (IAEA, Vienna). At. Strom, 15: 162-5(Sept. 1969). (In German).

The safety regulations of the International Atomic Energy Organization (IAEO) for the transportation of nuclear material are discussed. Details of the technical aspects of the regulations include packaging regulations for nonfissile and fissile material, authorization required, and transportation regulations. (auth)

454 INCINERATION TREATMENT OF COMBUSTIBLE RADIOACTIVE WASTE. 2. Matsumura, Takio; Sugimoto, Senichi (Ebara Mfg. Co., Tokyo). FAPIG (Tokyo), No. 53, 62-6(May 1969). (In Japanese).

An incinerator with a capacity of 100 kg/hr was constructed. After a cold test, the equipment was tested for solid radioactive waste treatment using ^{32}P as a tracer. The conditions for the incinerator are: furnace mean temperature is over 900°C while on the grate it is over 1,100°C, the regenerative effect is over 1 m^3/kg, the gas flow in the furnace is about 1 m/sec, while in the electric dust collector, it is below 1.5 m/sec, and the applied potential on the electric dust collector is 0.35 kV/mm. The effects of furnace temperature, gas flow rate, EP potential, and the relation between liquid volume in the scrubber and the decontamination factor (DF) were measured respectively. Overall decontamination factor of 10^3 was obtained, which is satisfactory. Generally speaking, when the furnace temperature drops below 900°C, the amount of dust suddenly increases, so that the DF has a tendency to decrease. In order to avoid this unfavorable tendency, it is desirable to operate the furnace constantly at 1,000 to 1,100°C. The increase of gas in furnace decreases the DF. Because of the increase of gas flow rate in the dust collector, the DF decreases. When the EP potential is low, the dust collecting capacity goes down remarkably. (NSA of Japan)

455 PROCEEDINGS OF THE 16TH CONFERENCE ON REMOTE SYSTEMS TECHNOLOGY, MARCH 11–13, 1969, IDAHO FALLS, IDAHO. National Topical Meeting on Remote Handling and Examination in the Fast Reactor Field. Hinsdale, Ill., American Nuclear Society, Inc., 1969. 330p. (CONF-690305).

Thirty-one papers were presented at the conference. A separate abstract was prepared for each paper. (J.R.D.)

For abstracts of individual papers see: 359, 402–409, 456–476, and 1056.

456 THE FFTF FUEL EXAMINATION FACILITY. Boyd, C. L.; Meyers, D. J.; Ramsey, E. B. (Battelle-Northwest, Richland, Wash.). pp 3-18 of Proceedings of the 16th Conference on Remote Systems Technology. Hinsdale, Ill., American Nuclear Society, Inc., 1969.
From Remote Handling and Examination in the Fast Reactor Field Meeting, Idaho Falls, Idaho. See CONF-690305.

The fuel examination facility of the Fast Flux Test Facility (FFTF) will serve the operations staff and experimenters with a reliable means, under controlled conditions, for performing prompt nondestructive examination of experiments and other components irradiated in the FTR. Examination data will be obtained from selected experiments that require reactor reinsertion, and from experiments or other core components whose irradiation is complete. The conceptual design provides shielded cell space with a controlled inert-gas atmosphere for conducting examination operations under unique conditions, including high levels of decay-heat output, alpha contamination, and radiation. Vertical handling of long core components, removal of residual sodium, and forced gas cooling of fuel components are provided to ensure that mechanical and metallurgical integrity of compounds is not jeopardized. (auth)

457 HEAD-END PROCESSING OF SPENT LMFBR FUEL. Watson, C. D.; Lowrie, R. S.; Groenier, W. S.; West, G. A.; Clinton, S. D. (Oak Ridge National Lab., Tenn.). pp 19-38 of Proceedings of the 16th Conference on Remote Systems Technology. Hinsdale, Ill., American Nuclear Society, Inc., 1969.
From Remote Handling and Examination in the Fast Reactor Field Meeting, Idaho Falls, Idaho. See CONF-690305.

The head-end reprocessing steps and equipment for recovering spent LMFBR fuel at a rate of five metric tons per day were investigated in a conceptual design study. The steps, which consist of receiving, cleaning, storage, disassembly, singularization, shearing, oxidation, and leaching, were scoped as to the problems and equipment involved and as to the feasibility of carrying out the steps in an alpha-gamma-contained facility. The study showed that an extensive developmental and evaluation program would be required to ensure satisfactory performance of the remotely operable, high-throughput continuous equipment and that none of the equipment or operations presented insurmountable engineering problems. In addition, results of the study indicated that two

processing lines would probably be required when spent LMFBR fuel is processed at rates greater than five metric tons per day in continuous operations. (auth)

458 FUEL-HANDLING SYSTEM DESIGN FOR THE WESTINGHOUSE 1000-MW(e) LMFBR STUDY. Sutherland, J. D.; Markley, R. A.; Ritz, W. C. (Westinghouse Electric Corp., Madison, Pa.). pp 39-45 of Proceedings of the 16th Conference on Remote Systems Technology. Hinsdale, Ill., American Nuclear Society, Inc., 1969.

From Remote Handling and Examination in the Fast Reactor Field Meeting, Idaho Falls, Idaho. See CONF-690305.

A hot-cell refueling system was selected for a 1000-MW(e) LMFBR plant study. In this system, all reactor refueling operations are carried out remotely inside an argon-filled hot cell. To prepare the reactor for refueling, a shield plug is removed from the reactor. Fuel is then transferred under sodium between the reactor and an adjacent fuel storage tank through a horizontal fuel transfer port connecting the two vessels. Areas adjacent to the refueling hot cell are provided for the inspection and preparation of new and spent fuel, and for the maintenance of refueling equipment and reactor internal components. (auth)

459 CURIUM SOURCE FABRICATION FACILITY. Robinson, R. A.; Schaich, R. W. (Oak Ridge National Lab., Tenn.). pp 49-55 of Proceedings of the 16th Conference on Remote Systems Technology. Hinsdale, Ill., American Nuclear Society, Inc., 1969.

From Remote Handling and Examination in the Fast Reactor Field Meeting, Idaho Falls, Idaho. See CONF-690305.

A curium source fabrication facility that was designed for preparing and encapsulating multigram quantities of ^{242}Cm and ^{244}Cm is described. After work in connection with the SNAP program indicated that an inert-atmosphere condition would be desirable because of an oxidation problem, the cells were first temporarily converted and then permanently converted to inert-atmosphere units. The changes that were involved are described. (auth)

460 START-UP OF SHIELDED FUEL EVALUATION FACILITY. Ludlow, J. O.; Coleman, L. F.; Eckels, T. W.; Grase, J. E. A.; Ross, L. E.; Slawecki, M. A. (Argonne National Lab., Ill.). pp 56-61 of Proceedings of the 16th Conference on Remote Systems Technology. Hinsdale, Ill., American Nuclear Society, Inc., 1969.

From Remote Handling and Examination in the Fast Reactor Field Meeting, Idaho Falls, Idaho. See CONF-690305.

A shielded fuel evaluation facility has been built for studies of irradiated ceramic fuels requiring a high-purity helium atmosphere. The systems required for facility operation have been tested and, after some corrections, operate satisfactorily. Remote installation of manipulator slave arms revealed some needed changes in handling equipment. Lighting in the facility is sufficient for operation. The facility is now ready for a helium atmosphere and final leak testing. (auth)

461 CONVERSION OF SRL BETA-GAMMA CELLS FOR PROCESSING 5 kg OF ^{244}Cm. Deily, G. J. (Savannah River Lab., Aiken, S. C.). pp 62-77 of Proceedings of the 16th Conference on Remote Systems Technology. Hinsdale, Ill., American Nuclear Society, Inc., 1969.

From Remote Handling and Examination in the Fast Reactor Field Meeting, Idaho Falls, Idaho. See CONF-690305.

Six 15-year-old beta-gamma cells were structurally improved to provide adequate shielding and containment for materials with high alpha activities. The concrete cell floor was removed and replaced with a stainless-steel floor; new roof slabs, ventilation system, windows, and manipulator ports were installed. Satisfactory shielding and containment have been demonstrated during the first 10% of a program to process 5 kg of ^{244}Cm in the converted cells. (auth)

462 OPERATING EXPERIENCE OF GENERAL ELECTRIC'S ALPHA CELL. Stimmell, G. L.; Howard, N. C. (General Electric Co., Pleasanton, Calif.). pp 78-82 of Proceedings of the 16th Conference on Remote Systems Technology. Hinsdale, Ill., American Nuclear Society, Inc., 1969.

From Remote Handling and Examination in the Fast Reactor Field Meeting, Idaho Falls, Idaho. See CONF-690305.

An alpha cell that has been operating successfully since April 1967 with no shutdowns for facility repairs or modifications is described. The difficulties encountered during the cell operation consist of inconveniences resulting from design limitations imposed by the existing facility. (auth)

463 SOME CONTAINMENT BOX EXPERIENCE AT ARGONNE NATIONAL LABORATORY. Doe, W. B.; Jackson, W. D. (Argonne National Lab., Ill.). pp 83-7 of Proceedings of the 16th Conference on Remote Systems Technology. Hinsdale, Ill., American Nuclear Society, Inc., 1969.

From Remote Handling and Examination in the Fast Reactor Field Meeting, Idaho Falls, Idaho. See CONF-690305.

Inert-gas containment boxes were used in beta-gamma caves for handling plutonium-containing irradiated fuels. Calculation of the toxicity of the fuel relative to previously handled uranium fuels showed there should be little increase in hazard. Positive gas pressure was then used in the box to maintain atmosphere purity even in the presence of box leaks. Radiation surveys after this kind of operation showed negligible escape of plutonium into the cave. (auth)

464 OPERATING EXPERIENCE WITH AN ARGON ATMOSPHERE AT THE FUEL CYCLE FACILITY. Hampson, D. C.; Sales, W. L.; Coleman, L. F. (Argonne National Lab., Idaho Falls, Idaho). pp 91-111 of Proceedings of the 16th Conference on Remote Systems Technology. Hinsdale, Ill., American Nuclear Society, Inc., 1969.

From Remote Handling and Examination in the Fast Reactor Field Meeting, Idaho Falls, Idaho. See CONF-690305.

A 66,000 ft^3 argon-atmosphere (95% argon, 5% nitrogen, <100 ppM water or oxygen) cell has been operated successfully in high radiation fields for over five years without human access to the cell. Since this successful operation is partially a result of tests and experiments that were conducted prior to and during the design phase of the facility, summaries of these tests are included where appropriate. Specific items or fields such as electrical insulation or atmosphere control are described. The design criteria, pre-design test results, operational experiences, and operational malfunctions and remedial actions are described. A composite source of information for individuals who may have need for it for future design of inert-atmosphere installations is intended. (auth)

465 DEVELOPMENT OF AN INERT-GAS CHAMBER FOR CREEP STUDIES OF IRRADIATED STAINLESS STEEL. Peterson, S. L.; Sheckherd, J. W.; De Mastry, J. A. (Battelle Memorial Inst., Columbus, Ohio). pp 112-15 of Proceedings of the 16th Conference on Remote Systems Technology. Hinsdale, Ill., American Nuclear Society, Inc., 1969.

From Remote Handling and Examination in the Fast Reactor Field Meeting, Idaho Falls, Idaho. See CONF-690305.

Modifications of standard Model-D Satec creep-rupture testing systems are described. These modifications were necessary to measure the creep properties of irradiated LMFBR cladding materials. The system was designed for prolonged operation in static inert gas at temperatures up to 1400°F. The system consists of a compact inert-gas chamber designed to facilitate remote loading and operation. The inert-gas chamber provides the desired specimen atmosphere while it allows the test to conform to applicable ASTM specifications. (auth)

466 FFTF INERT-GAS SELECTION STUDY. Dulin, R. V. (Battelle-Northwest, Richland, Wash.). pp 116-31 of Proceedings of the 16th Conference on Remote Systems Technology. Hinsdale, Ill., American Nuclear Society, Inc., 1969.

From Remote Handling and Examination in the Fast Reactor Field Meeting, Idaho Falls, Idaho. See CONF-690305.

The FFTF will be a prime test facility for fuels and materials for fast breeder reactor programs. Conceptual design of the FFTF includes a range of applications that will require inert cover gas for liquid-metal systems or as a protective atmosphere in enclosures for systems containing radioactive sodium. Because of the wide range of applications and their diverse requirements, extensive conceptual study effort was required to select the appropriate gas or gases for each application. The elements of a gas selection study performed in support of conceptual design of the FFTF inert-gas systems are presented. Results of the study should be helpful to those in the industry faced with similar conceptual development and selection problems. (auth)

467 OPERATING EXPERIENCE WITH THE FERMI FUEL HANDLING CASK CAR. Johnson, Kenneth P. (Power Reactor Development Co., Monroe, Mich.); Matte III, Joseph. pp 135-49 of Proceedings of the 16th Conference on Remote Systems Technology. Hinsdale, Ill., American Nuclear Society, Inc., 1969.

From Remote Handling and Examination in the Fast Reactor Field Meeting, Idaho Falls, Idaho. See CONF-690305.

The Enrico Fermi Atomic Power Plant was provided with a cask car for transporting spent fuel between the reactor building and the fuel and repair building. This car, a multi-station, self-contained unit, exhibited a variety of problems and defects in early operation. Analysis of these problems and the available solutions required to achieve satisfactory performance under designed operating conditions led to consideration of replacing the

cask car with a new facility. Several equipment suppliers encouraged this approach, which resulted in the selection of Atomics International to design and build a new fuel transport facility. The original cask car was retired from service upon delivery of this facility. (auth)

468 THE TECHNICAL EVOLUTION OF THE FERMI FUEL TRANSPORT FACILITY. Williams, R. O. Jr. (Atomics International, Canoga Park, Calif.); Hallinan, G. J.; Kirkby, R. C. pp 150-60 of Proceedings of the 16th Conference on Remote Systems Technology. Hinsdale, Ill., American Nuclear Society, Inc., 1969.

From Remote Handling and Examination in the Fast Reactor Field Meeting, Idaho Falls, Idaho. See CONF-690305.

The Enrico Fermi Atomic Power Plant is equipped with a fuel transport facility which functions to withdraw fuel subassemblies and special core components from either the fuel-storage or reactor transfer rotor, and to deposit the subassembly or component in the opposite rotor. The evolution of the fuel transport facility from the original multi-barreled machine to the present single-barrel machine is discussed. The decision to purchase the new machine was made after review of the maintenance requirements necessitated by design deficiencies in the original machine. (auth)

469 EBR-II HANDLING EQUIPMENT. Davis, Joe R. (Argonne National Lab., Idaho Falls, Idaho). pp 161-73 of Proceedings of the 16th Conference on Remote Systems Technology. Hinsdale, Ill., American Nuclear Society, Inc., 1969.

From Remote Handling and Examination in the Fast Reactor Field Meeting, Idaho Falls, Idaho. See CONF-690305.

Over seven years of experience has been gained with the EBR-II fuel handling system, and since May, 1963, fuel handling has been conducted in a high-temperature sodium environment. Normal problems were experienced, but the handling of fuel during this period can be considered successful. Modifications to increase the performance and reliability of the fuel handling equipment have been a continuing effort since the original system checkout. The on-site fuel reprocessing capability is a particularly unique and important feature of the EBR-II facility and one that influenced fuel-handling system design. Experience has proved the feasibility of the EBR-II fuel handling system and on-site fuel reprocessing concept for metallic-fueled fast reactors. (auth)

470 FUEL HANDLING MECHANISMS IN RAPSODIE AND PHENIX. Benoist, E.; Michot, G.; Reynes, L.; Thevenot, L. (CEN, Cadarache, France). pp 174-83 of Proceedings of the 16th Conference on Remote Systems Technology. Hinsdale, Ill., American Nuclear Society, Inc., 1969.

From Remote Handling and Examination in the Fast Reactor Field Meeting, Idaho Falls, Idaho. See CONF-690305.

The fuel handling mechanisms of RAPSODIE are described. Their principal characteristics are presented, including modifications during the course of two years of operation. The fuel handling principles of the PHENIX reactor that differ are also discussed. (auth)

471 TRANSFER SYSTEMS FOR IRRADIATED ALPHA–GAMMA MATERIALS AT DOUNREAY. Montgomery, K. R. (Dounreay Experimental Reactor Establishment, Scotland). pp 185-96 of Proceedings of the 16th Conference on Remote Systems Technology. Hinsdale, Ill., American Nuclear Society, Inc., 1969.

From Remote Handling and Examination in the Fast Reactor Field Meeting, Idaho Falls, Idaho. See CONF-690305.

The fast reactor and the alpha-gamma examination cells at Dounreay are being used in an extensive program of research on the irradiation behavior of plutonium-bearing ceramic fuels. Irradiated experimental fuel elements and fuel-element assemblies of the order of 30,000 MeV(c) activity are received into the hot cells from the core of the fast reactor and in some cases are returned for further irradiation in the reactor after nondestructive testing. Intercell transfer systems are used extensively during the normal examination procedures. Complete alpha containment techniques are used to remove waste from the cells and to make samples of fissile and nonfissile materials available for more detailed examination in smaller hot-cell units. (auth)

472 SHIPPING-CASK DESIGN CONSIDERATIONS FOR FAST BREEDER REACTOR FUEL. Irvine, A. R. (Oak Ridge National Lab., Tenn.). pp 197-204 of Proceedings of the 16th Conference on Remote Systems Technology. Hinsdale, Ill., American Nuclear Society, Inc., 1969.

From Remote Handling and Examination in the Fast Reactor Field Meeting, Idaho Falls, Idaho. See CONF-690305.

The high value of spent fuel from fast breeder reactors creates an incentive for recovery of that fuel as soon as practicable. The short decay period coupled with the high specific power of the fuel magnify the problems of fuel shipment. Safety and economy of shipment of this fuel can, it is believed, be accomplished by use of an exceptionally rugged containment system; energy-absorbing members to protect the cask from heavy impact loads; steel as the biological shield; sodium as primary coolant; and the arrangement of multiple fuel elements in close array inside a single fuel cavity. (auth).

473 EBR-II INTRASITE SPENT-FUEL SHIPPING CASKS. Malecha, R. F.; Coleman, L. F.; Fineman, P.; Kelecius, A.; Slawecki, M. A. (Argonne National Lab., Ill.). pp 205-11 of Proceedings of the 16th Conference on Remote Systems Technology. Hinsdale, Ill., American Nuclear Society, Inc., 1969.

From Remote Handling and Examination in the Fast Reactor Field Meeting, Idaho Falls, Idaho. See CONF-690305.

A change in the status of the Experimental Breeder Reactor II (EBR-II) from an experimental reactor to a neutron irradiation facility necessitated the construction of two different casks. The lead-shielded casks are to be used to transfer spent fuel to an on-site storage area. One cask has been designed and built which provides a water-cooled fuel cavity. The second cask is designed for bottom loading and incorporates an integral, totally enclosed, recirculating air cooling system for the fuel. (auth)

474 TRENDS IN IRRADIATED FUELS AND MATERIALS EXAMINATION. Evans, E. A. (Battelle-Northwest, Richland, Wash.); Hanson, J. E.; Cunningham, G. W. pp 214-17 of Proceedings of the 16th Conference on Remote Systems Technology. Hinsdale, Ill., American Nuclear Society, Inc., 1969.

From Remote Handling and Examination in the Fast Reactor Field Meeting, Idaho Falls, Idaho. See CONF-690305.

Reflections on the trends in irradiated fuels and materials examinations show that post-irradiation examination are becoming more complicated, and more detail and precision are continuously being demanded from them. Because an increase in the number of well characterized fuel and material specimens is anticipated, considerable thought and emphasis must be given to remote systems technology to obtain the maximum information from these irradiation experiments. The large numbers of specimens to be examined will require the application of automation and electronic data processing to minimize costs and time. Basic or research-oriented fuels and materials studies require more sophisticated examination facilities to accommodate reactive materials and provide greater accuracy and precision of measurements. Such studies will also require application of in-reactor diagnostics to better understand the behavior of fuels and materials under irradiation. (auth)

475 TRANSFER AND ANALYSIS OF HIGHLY RADIOACTIVE MATERIALS IN A SHIELDED ELECTRON MICROPROBE. Natesh, R.; Koprowski, B. J.; Butler, E. M.; Donahue, D. A. (Argonne National Lab., Ill.). pp 243-52 of Proceedings of the 16th Conference on Remote Systems Technology. Hinsdale, Ill., American Nuclear Society, Inc., 1969.

From Remote Handling and Examination in the Fast Reactor Field Meeting, Idaho Falls, Idaho. See CONF-690305.

A pneumatic transfer system has been designed and built to provide rapid and safe transportation for highly radioactive bulk samples from a hot-cell storage area to a shielded electron microprobe. Remote specimen transfer can be accomplished by the microprobe operator in less than two minutes. Experiments have been performed on specimens of irradiated UO_2–PuO_2 fuel in the shielded probe to determine the corrections for background radiation. (auth)

476 REMOTE MECHANICAL PROPERTY STUDIES OF FAST REACTOR MATERIALS. DeMastry, J. A.; Peterson, S. L.; Sheckherd, J. W.; Wullaert, R. A. (Battelle Memorial Inst., Columbus, Ohio). pp 253-60 of Proceedings of the 16th Conference on Remote Systems Technology. Hinsdale, Ill., American Nuclear Society, Inc., 1969.

From Remote Handling and Examination in the Fast Reactor Field Meeting, Idaho Falls, Idaho. See CONF-690305.

A new mechanical testing facility for use in studying the behavior of cladding and structural materials was developed. This facility is equipped to study tensile, stress rupture, creep, fatigue, tube pressurization, fracture mechanics, and instrumented impact properties over a wide range of temperatures. Examples of data obtained from recent programs are presented. (auth)

477 VERTICAL ASSEMBLER–DISMANTLER (Sept. 1967) (Engineering Materials). (Argonne National Lab., Illinois). (CAPE–1931).

30 drawings.

A vertical assembler-dismantler (VAD) is described that performs all remote operations necessary to assemble or disassemble all types of EBR-II fuel, blanket, control, and safety elements, and FFTF test assemblies. It replaces the vertical assembly and horizontal dismantler machines previously used. The equipment demonstrates improved reliability and efficiency

through simplified construction and capability to position the work in range for optimum manipulation and viewing. Fuel pins and test assemblies are maintained in a vertical position, which prevents disruption of the Na bond. The VAD consists of five major units attached to a vertical structure or frame. These units being the positional slide, hexagonal tube cutter, force boom, fuel element remover and loader, and welder. The support structure or frame stands ~11.5 ft above the cell floor and extends 6 ft into a floor pit. The positional slide supports the subassemblies held in the VAD; directs cooling air through an irradiated subassembly to remove fission-product heat; houses the rotational drive and chuck which rotate the subassembly for cutting the hexagonal tube during disassembly; raises or lowers the subassembly; and supports jigs, clamps, and fixtures used in assembly and disassembly. Hexagonal tubing is severed during disassembly operation by a pneumatically operated cutting mechanism. Two pipe cutting wheels are used. The force boom raises and lowers the hexagonal tube over the elements or capsules during assembly or disassembly operations. A grapple, contained in the force tube, transfers fuel elements and subassemblies to and from the unit. The grapple is capable of cooling the subassembly during transfer. The fuel element remover and loader (FERL) aids in removing and loading elements, and subassemblies from and onto a T-bar grid. The welder, which is mounted on ball casters, is positioned around the subassembly, to weld the lower end of the hexagonal tube to the lower adapter. The cooling system is connected to the grapple for axial cooling, and for cooling the element array after the tube is removed. Up to 120 cfm of air can be directed axially through the fuel subassembly. The cooling system can remove 3 kW of heat and keep the maximum temperature of the fuel pins below 600°F. (For details see TID-4100 Suppl. 55) (See also 23: 37615). (F.S.)

Vacuum Engineering

Refer also to abstracts 951, 952, 968, 969, 972, 995, 996, 999, and 1000.

478 (D-1-82-889) PERMANENT HIGH TEMPERATURE VACUUM TUBING JOINTS. Patten, J. W. (Boeing Scientific Research Labs., Seattle, Wash. Solid State Physics Lab.). Aug. 1969. 12p.

A new method has been developed for producing permanent tube joints exhibiting decreasing leak rate with increasing service temperature. This allows leak testing of vacuum connections at room temperature with the confidence that leak rates will not increase at elevated temperatures. A uniform internal cross-sectional area and smooth outer surfaces may also be readily provided. The process involves diffusion bonding of dissimilar metal sealing surfaces and lends itself to such problem materials as titanium and zirconium alloys. Splices and joints to dissimilar metal tubes, elbow, valves, and other fittings may be fabricated easily and reliably. Dimensional tolerances become less critical with increasing tube diameter. Joint strength is limited by the strength of the base metals. Experimental procedures for joint design, assembly, and testing are reported. (auth)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 67, 68, and 404.

General Detectors and Monitors

Refer also to abstracts 424, 544, and 720.

479 (BNL-14063) FACTORS AFFECTING PULSE SIZE IN SEALED TISSUE-EQUIVALENT COUNTERS. Baum, John W.; Woodcock, Ray C.; Kuehner, Alan V. (Brookhaven National Lab., Upton, N. Y.). [1969]. 15p. (CONF-691101-3). Dep. CFSTI.

From 2nd International Conference on Accelerator Dosimetry and Experience, Stanford, Calif.

The output from a tissue-equivalent (TE) Rossi-type LET spectrometer contains the necessary information for measurement of dose, dose equivalent and quality factor in fields containing mixed types of ionizing radiations. Studies aimed at (a) understanding the nature and extent of problems introduced when gas purity is not maintained by means of a gas flow system, and (b) exploring possible corrective measures are reported. Changes in pulse size caused by small pressure increases due to outgassing were compared to changes induced by adding equal amounts of air or counting gas to a chamber with an initial fill of 20 mm Hg of TE gas. The results showed exponential decreases in pulse size for few mm Hg increases of pressure. The rate constants associated with these pulse size decreases were: 0.33 $(mm\ Hg)^{-1}$ for outgas products, 0.135 $(mm\ Hg)^{-1}$ for air and 0.04 $(mm\ Hg)^{-1}$ for TE gas. The outgas products decreased pulse size to 50% of its initial value in about seven days. Mass spectrographic analyses revealed the presence of water vapor in the outgas products in addition to N_2 and O_2. Major improvements were demonstrated by use of P_2O_5 to continuously remove water vapor from sealed detectors. Pulse size decreased to 50% of initial values in 112 days in this test. It was concluded that water vapor is the principal source of pulse size variation with time in a sealed TE detector and that its undesirable effects can be reduced to an acceptable point by use of a suitable desiccant such as P_2O_5. Outgassing of all chamber materials for several months at about 70°C before, during, or after construction should achieve the same end. (auth)

480 (COO-1671-16) PARTICLE TRACKS IN EMULSION AND RELATED PHENOMENA. Katz, Robert; Kobetich, E. J. (Nebraska Univ., Lincoln. Behlen Lab. of Physics). [1968]. 37p. (CONF-690422-2). Dep. CFSTI.

From American Physical Society Meeting, Washington, D. C.

The structure of particle tracks in emulsion may be understood through the spatial distribution of ionization energy carried into the medium by δ-rays, through an analysis used earlier to find the cross section for inactivation of dry enzymes and viruses, and the response of NaI(Tl) to heavy ions. A parallel analysis yields criteria for the production of etchable tracks in dielectrics. The assumption that emulsion responds to a 1-hit process to the mean energy dose deposited in an emulsion grain yields predictions of grain count, the blackness profile, and the width of heavy ion tracks in emulsion. (auth)

481 (COO-1671-17) PARTICLE TRACKS IN CONDENSED MATTER. Katz, Robert; Kobetich, E. J. (Nebraska Univ., Lincoln. Behlen Lab. of Physics). [1968]. 28p. (CONF-690429-1). Dep. CFSTI.

From 2nd L. H. Gray Conference, Cambridge, England.

A proposed theory of track formation attributes observed effects to the spatial deposition of energy by secondary electrons. The theory is compared to experimental observations in a variety of fields, with good results. In contrast, linear measures of the interaction of charged particles with matter (LET, primary excitation, primary ionization, restricted energy loss) are unsuitable parameters through which to describe particle tracks, except in limiting cases, because many detection media are saturable. Energy deposited close to a particle's path often produces a disproportionately small response, because of overkill. (auth)

482 (N-69-35895) STUDY OF HIGH RESOLUTION PLASTIC TRACK DETECTORS OF HEAVY COSMIC RAYS. Final Report. Price, P. B.; Fleischer, R. L.; Miller, A. A. (General Electric Co., Schenectady, N. Y. Research and Development Center). Aug. 1969. Contract NAS9-8868. 63p. (NASA-CR-101881). CFSTI.

Effects of ionizing radiation on surface etching rates of plastic films as a function of irradiation dose are evaluated by weight loss per unit area after the processed films are dried in a vacuum. Of the numerous plastics studied, Lexan polycarbonate in 250 μ thick sheets and Kodacel unplasticized cellulose triacetate in 125 μ sheets show the following acceptable qualities: (1) uniformity of response; (2) absence of flaws that etch preferential; (3) retention of latent tracks; (4) outstanding optical quality of etched tracks; (5) increased etch rates at high ionization rates; (6) ultimate shelf life; and (7) sensitivity and resolving power for relativistic particles from $Z \approx 30$ up to at least 100. None of the cellulose nitrates and polyesters studied perform as well as the above mentioned plastics. (USGRDR)

483 (NP-18022) STUDIES ON THE APPLICABILITY OF A ZINC SULPHIDE SCINTILLATION DETECTOR AND A SEMICONDUCTOR DETECTOR FOR ON-STREAM ALPHA ACTIVITY MEASUREMENTS. Wichmann, H. P.; DeCarolis, M.; Mongon, A.; Eschrich, H. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). May 1965. 21p. (ETR-241). Dep. CFSTI (U. S. Sales Only).

The applicability of a ZnS scintillation detector for continuous alpha activity monitoring of liquid streams was investigated using a laboratory scale loop. The ZnS detector was brought into direct contact with various solutions of uranium in nitric acid in order to measure the alpha activity. Alpha activity measurements of uranium solutions were also carried out with a semiconductor detector. The influences of high beta and gamma radiations on the alpha measurements were evaluated and the possibilities of an electronic discrimination for those radiations were studied. Results and proposals for the use of the two types of detectors are given. (auth)

484 (NVO-294-1) PROJECT GASBUGGY ON-SITE RADIOLOGICAL SAFETY AND MEDICAL SUPPORT SERVICES, OCTOBER 11, 1967-JANUARY 24, 1968. (Eberline Instrument Corp., Santa Fe, N. Mex.). June 7, 1968; Revised Aug. 1, 1969. Contract AT(26-1)-294. 37p. (PNE-G-47). Dep. CFSTI.

Eberline Instrument Corporation provided medical and radiation monitoring support services for Project GASBUGGY, the first experiment in which a nuclear explosive was used to stimulate the production of natural gas. There was no radiation exposure of onsite personnel attributable to the GASBUGGY detonation or drillback. Hazardous quantities of radioactive material were not released into the environment. The biosphere of the Carson National Forest, in which the experiment was conducted, was not contaminated with radioactive material. (auth)

485 USE OF Ni-INTEGRATORS OF NEUTRON FLUXES AT ARBITRARY IRRADIATION REGIMES. Kadlec, Vladimir; Svec, Pavel; Vitek, Miroslav (Inst. of Nuclear Research, Rez, Czech.). Jad. Energ., 15: 335-40(1969). (In Czech).

Ni-foils have been used in fast neutron flux measurements for time integration at stationary irradiation. The methods described herewith considerably extend the application possibilities of these integrators. The irradiated Ni-foils and the described equations enable the evaluation of integral neutron fluxes at arbitrary irradiation régime. Further, a method of simultaneous measurement of thermal and fast neutrons (at $\Phi_{th} \geq 5.10^{13}\ n/cm^{-2}.s^{-1}$) with the use of one Ni-foil is described. Diagrams for rapid evaluation of calculations are added. All steps have been programmed for the GIER-computer in the Institute. (auth)

486 TRITON X-100 SCINTILLANT FOR COUNTING ^{45}Ca IN BIOLOGICAL FLUIDS. Nadarajah, A.; Leese, B.; Joplin, G. F. (Royal Post Graduate Medical School, London). Int. J. Appl. Radiat. Isotop., 20: 733-4(Oct. 1969).

The Triton X-100 scintillant system was explored for the estimation of calcium-45 in serum and urine without any prior processing of the samples. The principle of this technique is that the emulsifying agent Triton X-100 forms a stable mixture of water and toluene which is suitable for liquid scintillation counting. This method permits the counting of calcium-45 contained in 2 ml of serum or urine with a counting efficiency of approximately 65 per cent. The 95 per cent confidence limit of a single measurement (i.e., including the error of internal standard addition) based on 100 replicates was ±3.6 per cent. The method has since been used satisfactorily to count several hundred serum and urine samples with activities as low as 3 times the background rate. (UK)

487 MEASURING TECHNIQUE OF LOW LEVEL RADIOACTIVITY. Yanagishita, Kazuo; Iwakishi, Akira (Mitsubishi Electric Corp., Amagasaki, Japan). Mitsubishi Denki Giho, 43: 1215-20(Sept. 1969). (In Japanese).

For the purpose of measuring low level radioactivity, an iron

room of 1 m^3 volume has been constructed with its 20 cm thick walls lined with lead, cadmium, copper, and acrylic plastic. Thus it has been realized to provide a low background iron room such that its radioactivity is $\frac{1}{20}$ of an ordinary room. On the other hand statistical errors are liable to pose problems when a low level spectrum is measured by means of a pulse height analyzer. With the aim of reducing errors, an optimum smoothing calculation code has been developed by making use of an optimum filtering method. Through a joint application of these two kinds of techniques, it has been successful in extending the lowest limit of radioactivity measurement to 10^{-9}. An example of measuring human radioactivity is presented. (auth) (NSA of Japan)

488 RADIATION MONITORING SYSTEM. Iwai, Masaru; Kichishima, Uichi (Mitsubishi Electric Corp., Kobe, Japan. Kobe Works, Japan). Mitsubishi Denki Giho, 43: 1178-83 (Sept. 1969). (In Japanese).

The radiation monitoring system is installed widely in such premises as nuclear power stations, nuclear power research laboratories, radioactive materials handling arrangements, radiation generating facilities, and colleges and laboratories where radiation is put into use. The objective of the system is to safeguard personnel against the hazard of radiation. In nuclear reactors it is employed to detect abnormality in the plant. Outdoor radiation monitors, monitors used for nuclear reactor plants, and general-purpose monitors are described. (auth) (NSA of Japan)

489 CONCERNING THE SENSITIVITY OF END-WINDOW COUNTERS OF BETA RADIATION OF TYPE MST-17, SI-2B, SBT-7 TO GAMMA AND TO ^{238}Pu AND ^{241}Am CONVERSION RADIATION. Gryzina, V. V.; Polyukhov, V. G.; Popov, Yu. S. Radiokhimiya, 11: 370-1(1969). (In Russian).

The sensitivity of the end-window counters to alpha-emitters was measured relative to ^{90}Sr and ^{90}Y standards. The relative solid angle of the measurements constituted 0.10 for the MST-17 and SBT-7 counters and 0.14 for the SI-2B counter. Each preparation was measured at least five times. The results are tabulated. The SBT-7 counter was found to be least sensitive to gamma and ^{238}Pu and ^{241}Am conversion spectra. This is explained by the composition of the gas filling. Thus, the SBT-7 counter is best for measurement of weak beta activity in a background of intense alpha radiation. It was also established that counters with thin mica windows without aluminum filters of 10 mg/cm^2 record alpha radiation and characteristic x radiation from ^{238}Pu and ^{241}Am. An aluminum filter can be used to eliminate the alpha spectrum and most of the x radiation. (tr-auth)

490 A TWO-TRANSISTOR GEIGER-MUELLER COUNTER QUENCH CIRCUIT. Matthews, K. (California Inst. of Tech., Pasadena). Rev. Sci. Instrum., 40: 1511-12(Nov. 1969).

The design of a two-transistor multivibrator type quench circuit is described. The device uses only ½ W and attaches directly to the end of a G-M tube 5 cm in diameter. The circuit can be used with non-self-quenching counters and to reclaim old self-quenching counters. It can be used with new self-quenching counters to prolong their life and produce a constant dead time. Testing with a high energy cosmic ray experiment has continued for three years. (J.C.W.)

491 CRYOSTAT-SPECTROMETER SYSTEM FOR PRECISION MEASUREMENT OF LATTICE PARAMETERS OF IRRADIATED MATERIALS. Gruber, E. E.; Blewitt, T. H.; Tesk, J. A.; Sharma, B. D.; Black, R. E. (Argonne National Lab., Ill.). Rev. Sci. Instrum., 40: 1429-32(Nov. 1969).

A liquid helium cryostat and associated equipment to measure the lattice parameter of low temperature neutron irradiated materials are described. The cryostat is designed so that the irradiated capsule is a demountable subassembly of the helium chamber. The capsule, a small vacuum insulated Dewar, can be irradiated in a liquid helium environment and transferred to the cryostat system for measurement without intermediate warmup above 4.2°K. (auth)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 62, 66, 69, 70, 72–78, 83, 85, 86, 88–90, 92, 517, and 521.

492 (COO-1120-83) IOSUP: A CONVERSATIONAL MODE, NUCLEAR DATA ACQUISITION PROGRAM PACKAGE FOR THE UNIVERSITY OF KANSAS NUCLEAR STRUCTURE LABORATORY IBM 1800 COMPUTER. Lockwood, L. A. (Kansas Univ., Lawrence. Nuclear Physics Lab.). [nd]. Contract AT(11-1)-1120. 165p. Dep. CFSTI.

IOSUP, a conversational mode nuclear data acquisition program package, is described. The program consists of a group of special I/O routines for facilitating the transfer of pulse-height spectra between the various I/O devices on the IBM 1800 computer. A computer listing of operating instructions is included. (J.W.R.)

493 (KFK-981) REAL TIME COMPUTATION OF CROSS CORRELATION FOR PSEUDORANDOM TIME-OF-FLIGHT EXPERIMENTS. Ehret, G.; Glaeser, W.; Nehmer, J. (Kernforschungszentrum, Karlsruhe (West Germany)). May 1969. 14p. (CONF-690301-7). Dep. CFSTI (U. S. Sales Only).

From Conference on Computer Systems in Experimental Nuclear Physics, Skytop, Pa.

The information attainable in time-of-flight experiments per unit time can be increased in many applications by pseudorandom pulsing, allowing a maximum duty cycle of 0.5. However, it is impossible to make any direct decision on the transfer function (the desired information) from the measured response function. If the necessary cross correlation calculations will be done on line the monitoring of the experiment and the application of a simple decision theory on its progress is possible. For 10^3 time channels typically 10^6 multiplications have to be made. The design and performance of a correlator system which is intended for thermal neutron spectroscopy using a Telefunken TR 86 computer is described. (auth)

494 (ORNL-TM-2707) THE DEVELOPMENT OF A SPECTROMETER AND THE MEASUREMENT OF THE NEUTRON SPECTRUM FROM THE HEALTH PHYSICS RESEARCH REACTOR BETWEEN 50 keV AND 450 keV. Stone, D. R.; Thorngate, J. H.; Crase, K. W.; Brown, M. D.; Carver, D. W. (Oak Ridge National Lab., Tenn.). Nov. 1969. Contract W-7405-eng-26. 39p. Dep. CFSTI.

A proton-recoil telescope neutron spectrometer was developed to measure neutrons having energies between 50 keV and 450 keV. The proton radiator was a 17 $\mu g/cm^2$ thick anthracene film separated a distance of 83.82 cm from a ZnS scintillation detector. A magnetic analyzer was used between the radiator and detector to determine the momentum of the recoiling protons. The ORNL 3 MeV Van de Graaff accelerator was used to obtain the detector response as a function of proton energy, and the DOSAR Low Energy Accelerator was used to calibrate the magnetic field of the spectrometer. Spectral measurements of neutrons with energies between 50 keV and 450 keV were made 50 cm from the Health Physics Research Reactor. The results agreed well with a portion of measurements made previously with a ^6Li spectrometer, but the agreement with a calculated form of the Godiva II spectrum for this energy region was not as good. However, good agreement with the Godiva II spectrum for the energy region of interest would not be expected, since the Godiva II core configuration is smaller than the HPRR and the fuel is not alloyed with molybdenum as is the HPRR. (auth)

495 REACTION ELECTRON- AND GAMMA-SPECTROSCOPY. PRESENT STATUS AND PROSPECTS OF ITS FUTURE DEVELOPMENT. Sakai, M. (Tokyo Univ.). pp 57-85 of Future of Nuclear Structure Studies. Vienna, International Atomic Energy Agency, 1969.

From Panel on Future of Nuclear Structure Studies, Dubna, USSR. See STI/PUB-220; CONF-680723.

Experimental procedures and the theoretical background in reaction electron- and gamma-spectroscopy are reviewed and some examples are presented. As an application of the technique in rather low energy reactions, the gamma-ray spectroscopy of proton capture where the nuclear reaction proceeds via an isobaric analogue state is described and its physical meaning is illustrated. Timing methods and several topics are mentioned as new research fields of this technique. (auth)

496 ENERGY DEPENDENCE OF WHOLE-BODY GAMMA SPECTROMETER. Yuzgin, V. S. Izmer. Tekh., No. 8, 60-2 (Aug. 1969). (In Russian).

The efficiency of a single-crystal whole-body gamma spectrometer was calculated by the Monte Carlo method for photon energies of 0.364, 0.661, 1.17, 1.46, 1.83, and 2.75 MeV. Measurements were made using a phantom. (tr-auth)

497 OVEN FOR A NEUTRON SPECTROMETER, TO 1000 K. Bezdek, H. F. (Univ. of Colorado, Boulder); Schmunk, R. E.; Finegold, Leonard. Rev. Sci. Instrum., 40: 1397-8 (Nov. 1969).

A simple oven is described for keeping single crystal samples at high temperatures, for thermal neutron scattering work. Neutron transmission and reflection problems are solved, and sample temperatures can be held to a band of 2°K for several hours. (auth)

High Energy Physics Instrumentation

Refer also to abstract 1499.

498 (CERN-Trans-69-17) OPTIMUM CONDITIONS FOR APPLYING THE "INEFFICIENT COUNTER" METHOD FOR SEPARATING PARTICLES ACCORDING TO THEIR PRIMARY

IONIZING POWER. Tyapkin, A. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). Translated by A. T. Sanders from report JINR-P1-3686. 11p. Dep. CFSTI (U. S. Sales Only).

A statistical analysis is presented for a multi-counter system using the "inefficient counter" method for measuring the primary ionizing power of particles, particularly used in the search for quarks with fractional charge and for the detection of rare particles with low ionizing power in a background of a large number of ordinary particles. (W.H.K.)

499 NEW REVOLUTION IN PARTICLE DETECTION. Lederman, Leon M. Comments Nucl. Particle Phys., 3: 101-6(July-Aug. 1969).

A review of the performance of radiation detectors is given. The development of the spark chamber technique extending space and time properties is outlined and discussed. The requirements of high-energy physics, multiwire proportional counters, and the future possibilities are covered. (J.F.P.)

Radiation Dosimeters

Refer also to abstracts 479 and 1111.

500 ERROR EVALUATION ON MULTI-DETECTOR METHODS IN NEUTRON MEASUREMENTS. Ryufuku, Hiroshi; Nakayama, Takashi (Japan Atomic Energy Research Inst., Tokai). Jap. J. Appl. Phys., 8: 1242-51(Oct. 1969).

It is possible by introduction of characteristic functional $K[\phi]$ to evaluate errors due to the approximation using multi-detector methods in measurements of neutron dose equivalent rate, and to show them in a figure in a simple manner for arbitrary spectra. Dose equivalent rate is given by $D = K[\phi]N_1$, where N_1 is the counting rate of one of the detectors. The maximum errors are determined by obtaining the maximum and minimum values of $K[\phi]$ represented in terms of the ratios of counting rates. Examples are given for two- and three-detector methods. Also, good approximations in the multi-detector methods are described by the use of the characteristic functional. (auth)

501 METHOD FOR MEASURING DOSES OF IONIZING RADIATIONS. Swisher, Joe A.; Coates, Arthur D. (to Secretary of the Army). U. S. Patent 3,475,607. Filed July 27, 1966.

A method for measuring doses of ionizing radiations comprising irradiating an olefin-type polymer material with gamma radiation in the presence of air is described. The oxidized material is then irradiated with neutrons thereby forming nitrogen-16. The formed nitrogen-16 rapidly decays to form oxygen-16 concurrently emitting high energy gamma and beta radiations. The emitted radiation is measured utilizing electronic means. (Offic. Gaz.)

502 METHOD OF DOSIMETRY DOSE AND TIME-LAPSE READ-OUT. Sidran, Claire M. U. S. Patent 3,475,606. Filed Dec. 13, 1966.

A method of dosimetry dose and time-lapse read-out is described. The deep trap read-out provides an indication of the radiation dose as in the prior art. Unlike the prior art, the shallow trap read-out is used together with the deep trap read-out to determine the time lapse since the radiation exposure. The initial shallow trap population at the time of exposure can be determined from the deep trap read-out. The ratio of the shallow trap read-out to the initial shallow trap population is then used to determine the lapse of time in accordance with the characteristics of the dosimeter. (Offic. Gaz.)

503 SEPARATE DETERMINATION OF FAST NEUTRON AND GAMMA-RADIATION DOSES BY POLYMER FILMS. Lavrentovich, Ya. I.; Yakimenko, G. S.; Zverev, A. B.; Kabakchi, A. M. At. Energ. (USSR), 27: 296-301(Oct. 1969). (In Russian).

A possibility of application of polyethylene and cellulose diacetate films for separate determination of irradiation doses caused by neutrons and gamma-rays has been studied. The objects under investigation were subjected to the ^{60}Co gamma-irradiation, 14 MeV deuteron and 28 MeV alpha-particle irradiation, as well as gamma-neutron pile irradiation, to elucidate the effect of the LET-value on the yields of some radiolysis products. The optical density changes of cellulose diacetate at 320 cm^{-1} are found to be a linear dose function in the region of 2 to 80 Mrad. The optical density of irradiated polyethylene at 966 cm^{-1} is also a linear dose function in the region of 10 to 100 Mrad. No dependence on the LET-value has been found. With the use of two films, the separate determination of gamma-irradiation and neutron doses in the case of their simultaneous action is shown to be achieved with an accuracy to ±3 per cent. (auth)

Radiometric Instruments

Refer also to abstracts 428 and 1486.

504 CRYOGENIC FUEL GAUGING APPARATUS UTILIZING NEUTRON ABSORPTION TECHNIQUES. Kraushaar, Robert, J. (to Simmonds Precision Products, Inc.). U. S. Patent 3,463,920. Filed Aug. 31, 1965.

A fuel gauging system is described for measuring the quantity of cryogenic propellant in a tank utilizing a trace material of ^3He in the pressurizing gas normally associated with the propellant in a closed tank. A density measurement is made of the trace gas by measuring the attenuation of a neutron flux passing through a gap of fixed length located within the tank. For this purpose there is provided a thermal neutron source and two neutron detectors and an absorption chamber. (Offic. Gaz.)

505 METHOD FOR DETERMINING THE SURFACE DENSITY AND THICKNESS OF SHEET MATERIALS AND FILMS. Fedotov, Igor Leonidovich; Yanushkovskii, Vladimir Alexandrovich; Takhar, Iegoshua Mikhailovich; Olshvanger, Boris Akibovich. U. S. Patent 3,452,202. Filed June 16, 1965.

A method is described in which a sheet of material is exposed to β-rays which pass through the material and are backscattered by the ambient gaseous medium behind the material to undergo return passage through the material and measured in a detector for giving information related to the value of the surface density or thickness of material. (Offic. Gaz.)

506 RADIOISOTOPIC CONVEYOR SCALES. PART II. PARAMETERS AND USEFULNESS OF THE WIT-2 TYPE SCALES. Scharf, W. (Office of Nuclear Apparatus Experimental Centre, Warsaw). Pomiary, Automat., Kontr., 14: 544-7(1968). (In Polish).

Design data as well as operation and performance results are presented for the WIT-2 radioisotope conveyor scales described in a previous paper. The weighing accuracy and the radiation hazards associated with these scales are discussed. (auth) (NSA of Poland)

507 RADIOISOTOPIC CONVEYOR SCALES. PART I. DESIGN OF THE WIT-2 TYPE SCALES. Scharf, W. (Inst. of Nuclear Research, Warsaw). Pomiary, Automat., Kontr., 14: 441-4(1968). (In Polish).

Anyone willing to make use of the advantages offered by conveyor transport is generally required to know the total weight of material handled by the conveyor over a specified time, as well as the value of momentary loads on the conveyor band. This end to meet, a new type has been developed of a conveyor scale equipped with a contactless sensor based on the method of gamma-radiation dispersion. The production of scales of such type has been launched by the Experimental Establishment of BUTJ Żerań of Warsaw. Type WIT-2 radioisotopic conveyor scales are designed for operation in team with band conveyors of 400 to 1200 mm belt width, with any inclination angle required and any predetermined speed. Weighing inaccuracy amounts on the average to ±2%, working capacity range to over 1500 t/h. (auth) (NSA of Poland)

508 AFTERGLOW PLASMA DIAGNOSTICS WITH A MICROWAVE SAMPLING RADIOMETER. Stenzel, R. L.; Gould, R. W. (California Inst. of Tech., Pasadena). Rev. Sci. Instrum., 40: 1461-6(Nov. 1969).

A simple wave guide arrangement has been developed for the study of microwave absorption and emission from a magnetized afterglow plasma column. The time and frequency resolved measurements are performed by a sampling radiometer. A comparison and null technique permits the direct measurement of the electron temperature. Continuous plots of the temperature vs frequency, magnetic field, and afterglow time are made possible by means of a servoloop. The width of the emission or absorption spectrum in the range of upper hybrid frequencies is used to derive the electron density which, together with the temperature measurement, allows a more complete analysis of the plasma decay. (auth)

Miscellaneous Instruments and Components

Refer also to abstracts 426, 429, 455, 490, 967, and 1056.

509 (CEA-CONF-1302) CONNECTION FOR ELEMENTS OF NUCLEAR PHYSICS (COPHYNUT). Mougel, J. F. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes

Nucleaires). [nd]. 7p. (In French). (CONF-690321-2). Dep. CFSTI (U. S. Sales Only).

From International Conference on Remote Data Processing, Paris, France.

An experimental device was developed with several modes of access to the computer (direct access, programmed access, automatic channels) or with auxiliary memories owing to a system operated by the intermediary of the programmed channel. The device makes it possible to establish, under the control of the program, links between data emitters and receivers with the principal memory being considered as one of them. The direct access is treated as a peripheral link. The characteristics and functioning of this COPHYNUT system are described. (J.S.R.)

510 (HMI-B-83) DISPLAY TERMINAL FOR COMPUTER CONTROLLED NUCLEAR EXPERIMENTS. Zahn, J. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). Aug. 1969. 59p. (In German). Dep. CFSTI (U. S. Sales Only).

Data are displayed on the Display Terminal in a 1024 × 1024 dot array by random or sequential point plot (isometric and MAP display). For controlling the display terminal the data block is preceded by a control word. Linear or logarithmic display, superposition of a graticule, stretching of the x-coordinate, differential discrimination of data in the sequential display mode, and data input by light-pen are possible. (auth)

511 (KFK-982) ON-LINE COMPUTER SYSTEMS FOR EXPERIMENTAL NUCLEAR PHYSICS AT KARLSRUHE. Cierjacks, S.; Ehret, G.; Hanak, H.; Krueger, G.; Schmidt, H. (Kernforschungszentrum, Karlsruhe (West Germany)). May 1969. 19p. (CONF-690301-6). Dep. CFSTI (U. S. Sales Only).

From Conference on Computer Systems in Experimental Nuclear Physics, Skytop, Pa.

Characteristic features of two on-line systems, namely a coupled CDC 160 A-8090 computer system called MIDAS and a CDC 3100 system, are described. MIDAS in its present version is a data acquisition and reduction system allowing on-line accumulation and totalizing of 256 K channels on a disk and sequential accumulation on magnetic tape. This system is shared by up to 10 experiments. For a typical 3-parameter experiment the handling of data will be discussed. The CDC 3100 is used for cyclotron experiments. For this computer a program controlled direct memory access for time-of-flight measurements has been built. It allows 15 K totalizing with 100 K cycle input rate. Electronical drifts are automatically controlled and corrected. For 4 parameter (n,x)-experiments in the neutron energy range 0.5–30 MeV with typical counting rates of 300 Hz the computer identifies secondary particles reducing the number of words to be stored. (auth)

512 (RISO-M-921) USE OF THE DIGITAL PLOTTER IN CONNECTION WITH GIER AND GIER ALGOL III. Hansson, Leif (Danish Atomic Energy Commission, Risoe, Research Establishment). Aug. 1969. 16p. Dep. CFSTI (U. S. Sales Only).

Procedures for the control of the digital plotter connected with the GIER computer are described. The procedures included are: plotline, plotgraph, plotcurve, plotsymbol, plottri, plotfunct, plotaxes, plottext, plotcopy, plotnumber, plotaxon, and plotlinax. (Denmark)

513 (RISO-M-923) SEMI-ANNUAL REPORT FOR THE PERIOD 1st OCTOBER 1968–31st MARCH 1969. (Danish Atomic Energy Commission, Risoe, Research Establishment). July 1969. 28p. Dep. CFSTI (U. S. Sales Only).

Developments in the Electronics Department are briefly described including progress on process control and automation, nuclear geophysical methods, and instrumentation for research. A list of publications during this period is included. (W.H.K.)

514 MASS SPECTROMETER HAVING MEANS FOR SIMULTANEOUSLY DETECTING SINGLE FOCUSSING AND DOUBLE FOCUSSING MASS SPECTRA. Noda, Tamotsu; Nisiwaki, Koji (to Hitachi, Ltd.). U. S. Patent 3,475,604. Priority date Sept. 30, 1965, Japan.

A double focussing mass spectrometer in which ions produced by an ion source are dispersed by a magnetic field in accordance with the mass numbers thereof is described. The dispersed ions are successively detected by a first ion collector with a sweep of the magnetic field to provide a single focussing mass spectrum of low resolution including a large amount of metastable ions, while a part of the ions directed to the first ion collector is led to an electric field through the first ion collector without detection thereby to be dispersed in accordance with their velocity. Ions having a specified velocity among the dispersed ions are detected by a second ion collector to provide a double focussing mass spectrum of high resolution simultaneously with the single focussing mass spectrum. (Offic. Gaz.)

515 ION CYCLOTRON DOUBLE RESONANCE SPECTROMETER EMPLOYING A SERIES CONNECTION OF THE IRRADIATING AND OBSERVING RF SOURCES TO THE CELL. Llewellyn, Peter M. (to Varian Associates). U. S. Patent 3,475,605. Filed May 2, 1967.

An ion cyclotron double resonance spectrometer is disclosed in which the observing limited oscillator also known as a marginal oscillator or oscillating detector, and the irradiating transmitter are connected in series to the resonance or analyzing cell to reduce coupling or irradiating power into the limited oscillator. The spectrometer includes an electrode structure contained in an evacuated envelope and immersed in a magnetic field of 3000 gauss. The electrode structure comprises a hollow elongated rectangular electrode array. An ion source region is disposed at one end of the electrode structure for ionizing gas and projecting a beam of ions axially of the electrode structure. An ion collector electrode is at the other end of the electrode structure for collecting the ion beam or portions thereof. An analyzer structure is disposed along the beam path between the ion source and ion collector for exciting and detecting cyclotron resonance of ions within the beam. In the analyzer region of the spectrometer, the ion beam is irradiated with a relatively strong radio frequency electric field at a first frequency obtained from a radio frequency transmitter to produce cyclotron resonance a first species of ions. Also in the same analyzing region and by means of common electrode structure a second RF electric field which is relatively weak is applied at a second frequency from a limited oscillator to excite and detect cyclotron resonance of a second species of ions. The irradiating transmitter and limited oscillator are connected in series with each other across the common analyzing electrode structure, whereby the relatively large transmitter RF potential is largely dropped across the high impedance electrode structure and relatively decoupled from the input of the limited oscillator. (Offic. Gaz.)

516 FUNDAMENTALS OF AEROSPACE INSTRUMENTATION. VOLUME 1. A SHORT COURSE ON INSTRUMENTATION FROM TRANSDUCERS TO DATA HANDLING. Tutorial Proceedings of the Fourteenth International ISA Aerospace Instrumentation Symposium, June 3–5, 1968, Boston, Massachusetts. Leak, J. (ed.). Pittsburgh, Instrument Society of America, 1968. 107p. (CONF-680617-(Vol.1)).

Nine papers are presented under the general headings of transducer principles and techniques, signal conditioning principles and techniques, and data acquisition principles and techniques. (W.H.K.)

517 THE CHALLENGE AND PROMISE OF THE NEW RESEARCH TOOLS: SOLID-STATE DETECTORS, COMPUTERS, AND ACCELERATORS. Rasmussen, J. O. (Univ. of California, Berkeley). pp 45-56 of Future of Nuclear Structure Studies. Vienna, International Atomic Energy Agency, 1969.

From Panel on Future of Nuclear Structure Studies, Dubna, USSR. See STI/PUB-220; CONF-680723.

Nuclear structure research has been the beneficiary of many recent technical advances and in turn directly stimulated some advances. The exciting possibilities of the lithium-drifted germanium detector in gamma spectroscopy have only begun to be realized. The large amounts of high resolution data have put a premium on developing more automation of data handling through more sophisticated electronics and computers. Trends in accelerators are discussed, and reference tables listing isochronous cyclotrons and Tandem Van de Graafs around the world are given. Attention is directed to new frontiers of research in heavier ion accelerators, and tables of characteristics of existing and proposed heavy ion accelerators are given. The difficulties of obtaining multiply charged ions from known types of ion sources are considered, and the high charges resulting from Auger cascades of a K-vacancy are noted. It is suggested that intensive research on decay schemes and charge states of recoil products of nuclear reactions could lead to a practical accelerator of very heavy ions. As an example is discussed a possible arrangement in a Tandem Van de Graaff, where a deuteron negative ion beam strikes a source foil in the positive terminal, with recoil products or fission products accelerated to ground. Studies on noble gas and halogen fission products by gas transport systems and isotope separators are noted. Also reviewed are germanium gamma studies on unseparated ^{252}Cf spontaneous fission products using tape-transport methods and K X-ray coincidence. Next are reviewed studies on gamma and conversion-electron spectra of recoils and fission products in flight. The use of solenoidal or fringing-field magnets for conversion electron studies is discussed. Some of the qualitatively new aspects of nuclear studies with very heavy ion beams are mentioned. Finally, it is stressed that the research here called for on gamma cascades and charge states of nuclear reaction products is most extensive, may in part be done with modest equip-

ment, and will need the co-operative efforts of many workers. (auth)

518 INSTRUMENTATION IN THE AEROSPACE INDUSTRY. VOLUME 14. Proceedings of the Fourteenth International ISA Aerospace Instrumentation Symposium, June 3–5, 1968, Boston, Massachusetts. Leak, J. (ed.). Pittsburgh, Instrument Society of America, 1968. 344p. (CONF-680617-(Vol.14)).

A separate abstract was prepared for 1 of the 47 papers included. One of the remaining papers was previously included in NSA as 22: 42341, and the remaining 46 papers were not within the scope of NSA. (W.H.K.)

For an abstract of the individual paper see: 519.

519 CONSIDERATIONS INVOLVED IN AUTOMATION OF TEST FACILITIES. Washburn, B. W. (Los Alamos Scientific Lab., N. Mex.). pp 92-8 of Instrumentation in the Aerospace Industry. Vol. 14. Leak, J. (ed.). Pittsburgh, Instrument Society of America, 1968.

From 14th National Aerospace Instrumentation Symposium, Boston, Mass. See CONF-680617-(Vol.14).

Some of the less popular automation candidate areas and activities of test facilities and test operations are explored. The need for a total systems approach and sub-system integration as opposed to irregular and isolated automation is developed. (auth)

520 ELECTRON GUN FOR BEAMS OF MINIMUM CROSS SECTION: DIMENSIONING AND ANALYSIS OF BEAM PROPERTIES. Hoffmann, G. (Freie Univ., Berlin). Optik, 29: 506-19 (Aug. 1969). (In German).

The rules for dimensioning a Pierce electron gun were extended to obtain a beam of minimum diameter in a given distance z from the anode. The parameter of the gun, the radius ratio R_K/R_A, are given as a function of the anode lens field for different values of z. For a system with an anode voltage of 200 kV, a beam current of 10 amp, and a given distance z of 272 mm, $R_K/R_A = 2.165$ was obtained instead of $R_K/R_A = 2.275$ in the conventional case. The results derived are verified experimentally. Both the divergence of the beam and the beam diameter are smaller in a distance of z = 200 mm from the anode if $R_K/R_A = 2.165$ is used instead of $R_K/R_A = 2.275$. Concerning the beam current both kinds of dimensioning are equivalent. The emittance of the electron gun is measured and the brightness is calculated. With $R_K/R_A = 2.165$ the brightness of the gun is greater by about 30% than with $R_K/R_A = 2.275$. (auth)

521 USE OF MASS SPECTROMETRY IN SOME PROBLEMS OF NUCLEAR PHYSICS, AND RELATED APPLICATIONS OF THIS TECHNIQUE. Bernas, R.; Teillac, J. (Institut de Physique Nucleaire, Orsay, France). pp 99-114 of Future of Nuclear Structure Studies. Vienna, International Atomic Energy Agency, 1969.

From Panel on Future of Nuclear Structure Studies, Dubna, USSR. See STI/PUB-220; CONF-680723.

Topics include mass spectroscopy study of the mechanism of reactions at high energy, mass spectrometers operating directly in the external beam of an accelerator, and the study of specific nuclear reactions in connection with astrophysics. Future developments for mass spectroscopy in the fields of nuclear physics and nuclear astrophysics are discussed. (W.H.K.)

522 MODULAR SYSTEM BIN OF TRANSISTORIZED LABORATORY INSTRUMENTS USED IN NUCLEAR ENGINEERING. Polivka, Vaclav; Kubalek, Jiri (Research Inst. of Nuclear Instruments, Premysleni, Czech.). Jad. Energ., 15: 347-53(1969). (In Czech).

A conceptual approach to the modular system bin for radioactivity measuring instruments that have been developed and produced in the Research Institute of Nuclear Instruments is presented. A review of the instruments together with a schematic diagram for linking individual instruments, and the instruments proposed for broadening of the modular system bin are reported. (auth)

523 CONTACTLESS MEASUREMENT OF TEMPERATURES OF TITANIUM ALLOYS UPON RADIATION HEATING. Zernov, I. A. Izmer. Tekh., No. 8, 38-9(Aug. 1969). (In Russian).

The investigations showed the possibility of application of radiation pyrometers for automatically switching the radiation apparatus off upon achievement of the given temperature of heating (800°C). The obtained divergences of temperature upon heating under drop forging are completely permissible. (tr-auth)

524 ION-OPTICAL SYSTEM OF AN ENERGY-FOCUSING MASS SPECTROMETER FOR MICROIMPURITY ANALYSIS. Gall, R. N. Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 263-6 (Aug. 1969).

Translated from Zh. Tekh. Fiz., 39: 360-4(Feb. 1969).

The design and parameters of the ion-optical system of a mass spectrometer with energy focusing are given. The characteristic feature of the system is that the electrostatic condenser is located beyond the magnetic analyzer. It is shown that this arrangement offers the possibility of improving the resolving power at low levels by reducing the scattering of the ion beams on atoms and molecules of the residual gas. Experimental data on the resolving power and the shape of the uranium mass-spectrum line up to a level of 10^{-7} are given. (auth)

525 SIMPLE MASS SPECTROMETER. Dawson, P. H.; Hedman, J. W.; Whetten, N. R. (General Electric Research and Development Center, Schenectady, N. Y.). Rev. Sci. Instrum., 40: 1444-50(Nov. 1969).

A mass spectrometer of unusually simple construction is described. The three electrodes were hand formed from coarse stainless steel mesh. Despite the imprecise shape of the electrodes, the spectrometer has a half-height resolution of 75. The device is a three dimensional quadrupole, or ion trap type of mass spectrometer. It is operated so as to store a single m/e species at a time. After a suitable storage time, the ions are pulsed out of the trap into an electron multiplier for detection. The optimization of operating parameters and the ion buildup characteristics for various gases are presented. The performance of the instrument is compared to that of a magnetic sector mass spectrometer. The cracking patterns are simpler than for the magnetic analyzer. In contrast with the magnetic analyzer, no extraneous peaks due to ion desorption from surfaces are present. The lowest measured partial pressure was about 10^{-12} torr, and this was limited only by the minimum total pressure attained. Trace analysis capability of 1 part in 2500 was observed with little effort to optimize this property. (auth)

526 COLD CATHODE SOFT X-RAY SOURCE. Solomon, J. S. (Univ. of Cincinnati); Baun, W. L. Rev. Sci. Instrum., 40: 1458-60(Nov. 1969).

A versatile, simple, and inexpensive cold cathode soft x-ray source has been developed. Discharge characteristics are controlled either with an automatic pressure controller (APC) or a fine metering valve. X-ray output with an APC controlling the discharge is shown to have a count rate average standard deviation of ±1% or less for the first hour of operation and no greater than 1.5% for longer periods of time. The cold cathode source operates a mechanical pump vacuum which lends itself to windowless operation. The source may be used for x-ray radiography, luminescence, diffraction, spectroscopy, and as an excitation source for electron spectroscopy. (auth)

527 CALIBRATED SENSITIVITY MEASUREMENTS OF NUCLEAR MAGNETIC RESONANCE SPECTROMETERS. Adler, Michael S.; Senturia, Stephen D. (Massachusetts Inst. of Tech., Cambridge). Contract Nonr 1841 (51). Rev. Sci. Instrum., 40: 1481-3(Nov. 1969).

A definition of sensitivity for NMR spectrometers is proposed. This definition relates sensitivity directly to the minimum detectable steady state NMR absorption χ''. Furthermore, the definition is expressed in a form which makes explicit the sequence of measurements appropriate to its determination. A new solid state calibrator circuit is presented which is both simple and reliable. Its use in performing sensitivity measurements is described. (auth)

528 AN INEXPENSIVE MULTICHANNEL SCALER WITH CHANNEL WIDTHS OF LESS THAN 1 μsec. Silverberg, Eric C. (Univ. of Maryland, College Park). Rev. Sci. Instrum., 40: 1503-4(Nov. 1969).

A design is given of a multistop time-to-pulse height converter which extends the capability of an inexpensive pulse-height analyzer to perform multichannel time analysis with channel widths as low as 200 nsec. (J.C.W.)

529 VERSATILE VOLTAGE SENSITIVE PREAMPLIFIER FOR USE WITH PHOTOMULTIPLIER TUBES. Kennedy, E. J.; De Lorenzo, J. T.; Brashear, H. R. (Oak Ridge National Lab., Tenn.). Rev. Sci. Instrum., 40: 1504-5(Nov. 1969).

A versatile voltage-sensitive preamplifier is described which includes an input overvoltage protection for short term transients of ±1000 V, automatic balance control by a dc servoloop, the use of one power supply voltage, and the use of one coaxial terminated cable to provide both signal output and power to the amplifier. (J.C.W.)

530 VERSATILE SWEEP SYSTEM FOR THE VARIAN ASSOCIATED HA-100 NMR SPECTROMETER. Ovenall, Der-

ick W. (E. I. Du Pont de Nemours and Co., Wilmington, Delaware). Rev. Sci. Instrum., 40: 1506-8(Nov. 1969).

Design modifications for extending the range of the sweep system of a Varian Associates HA-100 nuclear magnetic resonance spectrometer while operating in a locked mode are discussed. (B.G.D.)

531 A SIMPLE, INEXPENSIVE HEATER FOR SOLID SAMPLES IN A MASS SPECTROMETER. Reichert, C.; Westmore, J. B. (Univ. of Manitoba, Winnipeg). Rev. Sci. Instrum., 40: 1515-16(Nov. 1969).

The development of a solid sample heater for a Hitachi–Perkin–Elmer RMU-6D single-focusing mass spectrometer equipped with a T-2M ion source is described. In the Hitachi instrument the solid sample is heated by inserting a probe containing the sample through a hole in a small copper block which is situated at the side of the ion source so that the sample can vaporize directly into the ionization chamber. The copper block is heated by the filament of a 300 W 110 V extended service incandescent light bulb. (J.C.W.)

532 THE USE OF PHOTOMULTIPLIER TUBES FOR PHOTON COUNTING. Foord, R.; Jones, R.; Oliver, C. J.; Pike, E. R. (Royal Radar Establishment, Malvern, Eng.). Appl. Opt., 8: 1975-89(Oct. 1969).

A number of photomultiplier tubes have been assessed for application in experiments where the counting of individual photoelectrons from the photocathode is necessary or advantageous. Pulse height distributions, signal-to-noise-in-signal ratios, overall quantum-counting efficiencies, time dependent statistical correlations, and dark current properties have been investigated and compared with theoretical expectations. A major finding has been the general low value of overall quantum-counting efficiency. Direct measurements of this figure have not, to our knowledge, been published previously. A second conclusion has been that, although there seems to be no reason why high performance with respect to each of the features considered should not be achieved in a single tube, we have not yet found one in which this is so. (auth)

Radiation Effects on Instruments and Instrument Components

Refer also to abstract 1109.

533 (N-69-33422) CHARGED PARTICLE RADIATION DAMAGE IN SEMICONDUCTORS. PART 14. STUDY OF RADIATION EFFECTS IN LITHIUM DOPED SILICON SOLAR CELLS. Downing, R. G.; Carter, J. R.; Scott, R. E.; Van Atta, W. K. (TRW Systems, Redondo Beach, Calif.). May 27, 1969. Contracts NAS7-100; JPL-952251. 153p. (NASA-CR-103788; TRW-10971-6014-RO). CFSTI.

For Jet Propulsion Lab., Pasadena, Calif.

Float zone lithium doped solar cells after 3×10^{14} e/cm^2 at 1.0 MeV have exhibited recovered maximum power points as high as 95% under solar illumination and about 90% under tungsten illumination. Similarly after 3×10^{15} e/cm^2 recovered maximum power points of 80% under solar illumination and 70% under tungsten illumination have been observed. In each case room temperature half anneal times are of the order of an hour. Crucible lithium doped solar cells exhibit the same recovery characteristics at about 80°C while being considerably slower at room temperature. Redistribution and carrier removal studies indicate a lithium removal rate during irradiation of 0.05 cm^{-1} which appears to result in a lithium-vacancy defect site active as a recombination center. Subsequent annealing results in further loss of lithium, implying a lithium-vacancy-lithium defect site which is inactive in the recombination process resulting in recovery of electrical characteristics. Minority carrier lifetime versus temperature measurements on both crucible and float zone lithium doped solar cells further confirm the absence of the A-center as a dominant recombination site in lithium doped n-type silicon. (auth) (USGRDR)

534 (N-69-33590) ACTION OF LITHIUM IN RADIATION-HARDENED SILICON SOLAR CELLS. Final Report, April 23, 1968–April 21, 1969. Brucker, G. J.; Faith, T. J.; Holmes-Siedle, A. G. (Radio Corp. of America, Princeton, N. J. Astro-Electronics Div.). Contracts NAS7-100; JPL-952249. 119p. (NASA-CR-103871; AED-R-3440). CFSTI.

For Jet Propulsion Lab., Pasadena, Calif.

The results of a program to study and analyze the action of lithium in producing a recovery of radiation damage in silicon solar cells are reported. The work performed has advanced the understanding of the defect interactions, dynamics, and general prospects of lithium solar cells. The dynamics of lithium in silicon has been studied under conditions analogous to those which would be experienced in a practical lithium solar-cell array in a high-flux trapped space-radiation situation, namely in orbit near Earth, Jupiter or any other planet. Tests on GFE cells irradiated to fluences from 10^{14} to 10^{16} e/cm^2 indicate that, to obtain good long-term stability in cells made from silicon of low oxygen content, the lithium density should be made as low as is compatible with maximum cell recovery for the fluence applied to the cells. Cells with high lithium concentration and steep gradients of lithium density near the junction show gross lithium motion near the junction over ≈1 year. (auth) (USGRDR)

535 (N-69-34379) RADIATION EFFECTS IN SILICON SOLAR CELLS. Quarterly Report. Naber, J. A.; Passenheim, B. C.; Berger, R. A. (Gulf General Atomic, Inc., San Diego, Calif.). July 10, 1969. Contract NAS7-100; JPL-952387. 38p. (NASA-CR-104066; GA-9483). CFSTI.

For Jet Propulsion Lab., Pasadena, Calif.

The nature of the defects responsible for the output degradation of silicon solar cells irradiated by space radiation, particularly the effects of lithium on the production and annealing of damage in silicon, is investigated. Samples of high purity silicon have been lithium diffused by the paint-on and lithium-tin bath techniques. Samples of various lithium content have been prepared, and the lithium content is being measured by room temperature resistivity and neutron activation analysis techniques. Both neutron and electron irradiation programs have been initiated. Lifetime degradation rates at 273° and 302°K have been measured as a function of neutron fluence. From isochronal and isothermal anneal data the annealing kinetics appear to be first order and are controlled by the diffusion rate of lithium in silicon. Results of the effect of the lithium concentration on the degradation and annealing of electron-irradiated lithium-diffused n-type silicon have been obtained. An electron spin resonance study of the irradiation production and anneal of the divacancy has been initiated. (auth) (USGRDR)

536 (N-69-34718) RTG SCIENCE INSTRUMENT RADIATION INTERACTIONS FOR DEEP SPACE PROBES. Final Technical Report, February 4–June 30, 1969. Kaminska, R. A.; Ryan, G. W.; Smith, C. A. (TRW Systems, Redondo Beach, Calif.). July 31, 1969. Contract NAS2-5222. 130p. (NASA-CR-73360). CFSTI.

The interference effects of radiation emitted by a plutonium–dioxide-fueled radioisotope thermoelectric generator (RTG) on scientific instruments carried onboard an RTG-powered spacecraft are studied. Scientific instruments commonly carried in spacecraft and the elements of the instruments most susceptible to the RTG radiation are identified. These elements, which included semiconductor detectors, plastic scintillators, CsI scintillators, and a number of other radiation detectors were exposed to a SNAP-27 fuel capsule assembly. The resultant spectral response of each detector was determined along with the effects of various separation distances, capsule orientations, and different shielding materials and thicknesses. A detailed analysis of the nuclear radiation emitted from the SNAP-27 fuel capsule was also performed, including the effect of fuel form age on the source spectrum. (auth) (USGRDR)

537 (N-69-34973) RADIATION EFFECTS IN SILICON SOLAR CELLS. Quarterly Report. Naber, J. A.; Passenheim, B. C. (Gulf General Atomic, Inc., San Diego, Calif.). Apr. 10, 1969. Contracts NAS7-100; JPL-952387. 14p. (NASA-CR-104137; GA-9312). CFSTI.

For Jet Propulsion Lab., Pasadena, Calif.

The nature of the defects responsible for the output degradation of silicon solar cells irradiated by space radiation, particularly the effects of lithium on the production and annealing of damage in silicon, is reported. Samples of high purity silicon have been lithium diffused by the paint on and lithium tin bath techniques. Samples of various lithium content have been prepared, and the lithium content is being measured by room temperature resistivity and neutron activation analysis techniques. The first of a series of samples has been investigated. Resistivity and minority carrier lifetime were measured as a function of temperature before and after irradiating the sample with 30 MeV electrons. During irradiation, the lifetime degradation and annealing rates were measured at room temperature and above, as a function of fluence. Isothermal anneals were performed in an effort to determine the temperature dependence of the annealing rate. (auth) (USGRDR)

538 (N-69-35123) SPACE RADIATION HAZARDS TO PHOTOGRAPHIC FILM IN THE APOLLO TELESCOPE MOUNT AND ORBITING WORKSHOP. Final Report. Hill, C. W.; Davis, D. N.; Parker, H. K. Jr. (Lockheed-Georgia Co., Marietta). May 1969. Contract NAS8-21266. 69p. (NASA-CR-61281; ER-10156). CFSTI.

A mathematical model of the Apollo Applications Program

cluster geometry has been constructed. Space radiation doses to Apollo Telescope Mount (ATM) photographic film and other experiment film throughout the cluster are computed. Radiation fogging density is estimated for the ATM film, and film degradation is found to be within tolerance limits. (auth) (USGRDR)

539 (N-69-35558) INVESTIGATION OF THE STRUCTURE OF RADIATION DAMAGE IN LITHIUM DIFFUSED SOLAR CELLS. Progress Report, February 3-June 30, 1969. Corelli, John C. (Rensselaer Polytechnic Inst., Troy, N. Y. Div. of Nuclear Engineering and Science). Contracts NAS7-100; JPL-952456. 11p. (NASA-CR-105289; PR-1). CFSTI.

For Jet Propulsion Lab., Pasadena, Calif.

The effects of irradiation by 1 to 5 MeV electrons on the optical properties of silicon doped with lithium concentrations in the range from 10^{15} to 10^{17} Li/cm^3 were studied. Damage was determined primarily by infrared spectroscopy in the range from 1 to 50 microns and through photoconductivity in the range from 0.5 to 10 microns. The electron irradiations were performed at ≈300°K. In the experiments, a paste composed of dispersed lithium metal (particle size <15 micron) and alumina (15 micron) mixed in mineral oil was applied to the surface of a silicon sample which was then heated at 450°C in an argon or helium gas environment. The diffusion times were varied from 10 min up to several hours, depending on the thickness of the sample and the desired lithium concentration. Preliminary findings on photoconductivity and infrared spectroscopy are discussed. (USGRDR)

540 (N-69-35632) DEVELOPMENT OF LITHIUM DIFFUSED RADIATION RESISTANT SOLAR CELLS. Final Report. Payne, P. (Heliotek, Sylmar, Calif.). Mar. 20, 1969. Contracts NAS7-100; JPL-952247. 68p. (NASA-CR-105318). CFSTI.

For Jet Propulsion Lab., Pasadena, Calif.

Lithium doped p-n solar cells were fabricated and delivered for radiation testing and analysis. Statistical analysis of the cell outputs was performed for each lot of cells. Significant improvements in cell efficiencies were made and particularly high efficiencies were obtained with crucible grown lithium cells. The average output ranged from 26.0 mW to 29.0 mW. Lithium evaporations and various lithium diffusion parameters were investigated. Boron diffusions were also studied and the uniformity of lithium cell output was improved. Investigation of sintering lithium cells showed that in some cases sintering can cause significant improvements in cell output. Measurements over a 2½ year storage period show that in most cases the losses were less than 2% in lithium cells. In general the crucible grown lithium cells showed improvements after storage. The float zone cells diffused at 425°C varied. The float zone cells diffused at 350°C had slightly lower characteristics after one year of storage and after two years showed slight improvement. (auth) (USGRDR)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 48, 63, and 271.

Basic Processes

Refer also to abstracts 114–127, 136, 137, 784, 786, 792, 840, 920, and 1972.

541 (CEA-CONF-1314) LUNG CLEARANCE: SILICOSIS AND ANTHRACOSIS. Jammet, H.; Lafuma, J.; Nenot, J. C.; Chameaud, M.; Perreau, M.; Le Bouffant, M.; Lefevre, M.; Martin, M. ([Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires]). [1969]. 12p. (CONF-690425-1). Dep. CFSTI (U. S. Sales Only).

From International Conference on Pneumoconiosis, Johannesburg, South Africa.

The kinetics of lung clearance of inhaled dusts was studied in cats, hamsters, and rats using ^{59}Fe-labeled iron oxide dust with a particle size below 5 microns, to simulate dust found in coal and uranium mines. The animals were placed in atmosphere exposure chambers and exposed to the dust for periods of 60 to 90 minutes duration. The radioactivity in the animals was measured by in vivo counting methods and whole-body scanning every day during the first 14 days and at various intervals during the next six months. Results showed that lung clearance proceeded in three phases, with rapid clearing of the nasopharynx during the first three days that resulted in removal of 40 to 60% of the radioactivity, followed by a slower phase of trachea clearance, and a slower phase for removal of the remaining small fraction of the radioactivity from alveoli. This phase extended to 100 days in some cases. The clearance rate varied among the animals used. The clearance of coal and silica dusts followed the same general pattern. (C.H.)

542 (COO-119-240, pp 243-61) BIOCHEMICAL CHANGES INDUCED BY INTERNALLY DEPOSITED RADIONUCLIDES IN BEAGLE DOG BLOOD: A STATISTICAL STUDY. Berliner, David L.; Stevens, Walter; Nabors, Charles J. Jr.; Maxwell, Richard E. (Utah Univ., Salt Lake City. Radiobiology Div.).

Effects of internally deposited radionuclides in Beagle dogs were studied. The radionuclides used were ^{239}Pu, ^{228}Ra, ^{226}Ra, ^{228}Th, and ^{90}Sr. Certain biochemical parameters were subjected to multivariate regression analysis. These were serum glutamic pyruvic transaminase, serum alkaline phosphatase, total serum protein, serum albumin, and serum globulins. Changes with age in control animals were evaluated statistically. Control animals showed increases in blood levels of alkaline phosphatase, total serum proteins, and total serum globulins with increasing age. Changes in the biochemical parameters studied are related to the individual radionuclide with respect to the site of its deposition, the dosage, and the elapsed time after injection. (auth)

543 (NYO-910-125) BIOLOGICAL EFFECTS OF RADIATION AND RELATED BIOCHEMICAL AND PHYSICAL STUDIES. PROPOSAL NO. 5. CHEMICAL AND BIOLOGICAL STUDIES ON NUCLEIC ACIDS AND DERIVATIVES. Progress Report, April 1, 1968–June 30, 1969. Brown, George B.; Bendich, Aaron (Sloan-Kettering Inst. for Cancer Research, New York). Sept. 30, 1969. Contract AT(30-1)-910. 12p. Dep. CFSTI.

The oncogenic effects of purine N-oxides were studied in rats. Results are reported from studies on the relationship of chemical structure to oncogenicity of guanine 3-N-oxide, 3-hydroxyxanthine, adenine-3-N-oxide, and hypoxanthine 3-N-oxide. Data on the radiation chemistry of solutions of 3-hydroxyxanthine, adenine, and guanine are included. (C.H.)

544 LIEGE WHOLE BODY COUNTER. I. STANDARDIZATION OF MEASUREMENTS OF TOTAL BODY POTASSIUM. Delwaide, P. A. (Univ. de Liege). Ann. Biol. Clin. (Paris), 27: 325-39(May-June 1969). (In French).

The Liege whole-body counter, mainly used for the measurement of the total body potassium, consists of a 4 π geometric scintillator, 18 photomultipliers and a 3-channel spectrometer. The nature of the scintillator (Plastifluor) is an innovation. Its technical characteristics are described, especially its efficiency, which has been shown to be excellent, and the resolution, which is relatively weak, limiting the possibilities of spectrometric differentiation. A method of standardization of the measurement of ^{40}K and ^{137}Cs in the body is described, together with the verifications obtained. It has been shown that the total potassium of the organism can be measured to an accuracy of 5% for a counting time of 200 seconds. (auth)

545 ESTIMATES OF PERIPHYTON MASS AND STREAM BOTTOM AREA USING ^{32}P. Nelson, D. J.; Kevern, N. R.; Wilhm, J. L.; Griffith, N. A. (Oak Ridge National Lab., Tenn.). Water Res., 3: 367-73(May 1969).

The standing crop of periphyton and actual surface area in a 100-m section of a small stream were estimated by applying material balance techniques to an experimental ^{32}P release. About 75 per cent of the introduced ^{32}P was retained initially by periphyton in the study section. Based on the quantity of ^{32}P in periphyton samples, per mg and per cm^2, the total standing crop of periphyton and the bottom area of the section were estimated as 1.5 kg and 560 m^2, respectively. (auth) (UK)

546 THE LEUKEMIC AND MONONUCLEOSIS CELL. III. DNA SYNTHESIS. Schumacher, H. R.; McFeely, A. E.; Maugel, T. K. (York Hospital, York, Pa.). Cancer, 24: 692-700(Oct. 1969).

Peripheral leukocytes from 22 patients with acute leukemia, 10 patients with infectious mononucleosis, and 10 normal controls were studied by means of autoradiography and liquid scintillation techniques using ^{14}C-formate and ^{3}H-thymidine. Infectious mononucleosis cells showed a predictable decline with both techniques with both isotopes over a definite time period. Acute leukemic cells showed more erratic results, but in general both techniques showed a decline of utilization of both isotopes immediately after treatment and a rise in the relapse and terminal stages. This erratic nature of leukemic cells was further demonstrated by two cases that were studied throughout the entire duration of the disease. The results showed that the acute leukemic blast cells from all cases revealed no marked increase in endogenous synthesis (^{14}C-formate incorporation) to account for resistance, but that individual cases may release cells with variable synthetic capability over a prolonged time period. Even though cells demonstrating a variable synthetic capacity were observed, the ^{14}C-formate-^{3}H-thymidine ratio remained constant in all stages. In the terminal stage, low incorporation of both isotopes into peripheral leukemic leukocytes was rare. In contrast, mononucleosis cells showed a greater ability to utilize ^{14}C-formate more efficiently than ^{3}H-thymidine, and, in the later stages of the disease, incorporation of these isotopes was similar to normal controls. (auth)

547 EFFECTS OF SEX HORMONES ON ANDROGEN METABOLISM. Mauvais-Jarvis, P.; Bercovici, J. P.; Floch, H. H. (CHU, Paris). Rev. Fr. Etud. Clin. Biol., 14: 159-68 (Feb. 1969). (In French).

Various sex hormones, labeled either with carbon-14 or tritium, were studied as to their effects on males and females. Sexual differentiation in males is associated with stimulation of enzymes leading to the reduction of testosterone into 17β-hydroxyandrostane steroids; probably, the stimulation is caused by the secretion of androgens at the beginning of male puberty. In normal females, estrogens of ovarian origin prevent this stimulation and inhibit the enzymes. (H.B.G.)

548 INTERSPECIES RADIOTOXICOLOGICAL CORRELATIONS AND EXTRAPOLATION OF ANIMAL DATA TO MAN. Slouka, Vlastimil (University Hospital, Hradec Kralove, Czech.). Strahlentherapie, 138: 213-17(Aug. 1969).

Experimental radiotoxicology may contribute to a better estimation of maximum permissible concentrations of radionuclides for man in two ways: By precise studies of all possible factors influencing the kinetics of radionuclides, and by a study of interspecies correlations and a mathematical expression of these correlations on the basis of kinetic models for individual radionuclides in different animal species. More data of that kind are needed for the estimation of reliable MPC of radionuclides for man with respect to low level and chronic exposure. (auth)

549 ALTERED METABOLISM OF SERINE IN RADIATION CHIMERAS. Kretchmar, A. L.; Price, E. J. (Univ. of Tennessee, Knoxville). Amer. J. Clin. Nutr., 22: 842-4(July 1969).

Male or female B6C3 F_1 mice were given 950-R total-body x irradiation at 12 to 16 weeks of age. Some were then each given 50×10^6 bone marrow cells taken from 30-day-old CD2 F_1 mice (homologous cells) of the same sex as the recipients by intravenous injection. Others were each given 5×10^6 cells from 35-day-old CD2 F_1 donors. A low mortality (3% in 120 days) and a high mortality (70% in 60 days) were seen in these respective groups.

Respiration pattern analysis (RPA) was carried out for the 1st hr after injection of 1 μCi of L-3-^{14}C-serine 2 weeks after irradiation. The typical $^{14}CO_2$ excretion pattern in control mice showed a rapid increase in specific activity, reaching a maximum at about 20 to 30 min followed by a steady decline. The pattern in mice treated with homologous bone marrow after irradiation was altered in two ways. The variance among individual mice was markedly increased and there was usually a much higher specific activity with a broader peak between 14 and 45 min. The respiration pattern of irradiated mice treated with isologous bone marrow was usually similar to that of control, untreated mice. There was a correlation between early alteration of serine metabolism and the subsequent incidence of mortality among mice with secondary disease. Whether abnormal RPA after injection of labeled serine accurately indicates the clinical prognosis on an individual basis is not established, but accumulation of data from many groups with a range of mortality should answer the question. Simple procedures with prognostic value would be helpful in management of humans with transplantation disease. The abnormal RPA after injection of L-3-^{14}C-serine may involve altered formate metabolism or disruption of the serine-glycine pathway. (BBB)

Metabolism, Physiology, and Toxicology

Refer also to abstracts 541, 693, 770, 867, and 922.

550 (AEC-tr-7090) METABOLISM AND TOXICITY OF THERAPEUTIC CHELATING AGENTS. REPORT NO. 1. COMPARATIVE INVESTIGATION ON THE EXCRETION OF EDTA AND DTPA IN THE URINE OF THE RAT. Harmuth-Hoene, Anna-Elisabeth. Translated by A. A. Horvath for Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex., from Strahlentherapie, 134: 110-22(1967). 20p. Dep. CFSTI.

The urinary excretion of ^{65}Zn and ^{14}C-labeled chelates of ethylenediaminetetraacetic acid (EDTA) and diethylenetriaminepentaacetic acid (DTPA) was studied in rats. It was shown that the observed retention of ^{65}Zn is due to isotopic exchange with endogenous Zn; no genuine splitting-off takes place. In addition, Zn-DTPA is capable of mobilizing endogenous Zn. The excretion rates of Ca- and Zn-chelates rise with increasing dosage. (auth)

551 (COO-119-240, pp 97-118) MICROSCOPIC DISTRIBUTION OF ^{241}Am IN THE BEAGLE. Taylor, G. N.; Jee, W. S. S.; Williams, J. L.; Burggraff, B.; Angus, W. (Utah Univ., Salt Lake City. Radiobiology Div.).

Americium-241 retention in the soft tissues of the beagle following a single intravenous injection of a citrate buffered solution was significantly elevated in the following sites: In the hepatic cells of the liver, in macrophages containing engulfed hemosiderin, in calcified foci, such as those occasionally found in the renal medulla and in certain PAS positive connective tissue structures. The latter accounted for relatively high concentrations in the interfollicular areas of the thyroid, the renal corpuscles, the media of the smaller arterioles, and the cartilaginous structures of the lungs. Death resultant to kidney and liver failure occurred at approximately 400 days following injection of 2.8 μCi ^{241}Am/kg. (auth)

552 (COO-119-240, pp 119-28) THE DISTRIBUTION OF ^{241}Am WITHIN SELECTED SOFT TISSUES OF BEAGLE DOGS. Stevens, W.; Stover, Betsy J.; Bruenger, F. W. (Utah Univ., Salt Lake City. Radiobiology Div.).

The short term distribution of ^{241}Am after intravenous injection was studied in liver, kidney, spleen, thyroid, adrenal, pituitary, muscle, and several connective tissue structures of two beagle dogs. At autopsy the tissues were removed, weighed, frozen in liquid N_2, homogenized and then fractionated by differential centrifugation. Of the whole organs, the highest concentration of ^{241}Am was found in the liver (0.174% D/g), followed by the thyroid (0.046% D/g). Concentrations in other organs were at least one order of magnitude lower with skeletal muscle having the lowest concentration. Among subcellular fractions, significant amounts of the nuclide were found within the microsomes of liver, kidney, and spleen and in the mitochondrial fraction of liver and spleen. Of the total burden of ^{241}Am in these organs a large fraction was present as a soluble component. The ^{241}Am concentration in the thyroid was higher than the concentration in bone and greatly exceeded that of the adrenal and pituitary. The thyroid was unique in that approximately 90% of its ^{241}Am burden was in the connective tissue residue and the concentration in this fraction was only slightly lower than that of the whole liver. In the adrenal only about 30% was associated with the connective tissue fraction. Generally, all connective tissue structures (omentum, dura mater, and loose connective tissue) contained only small amounts of ^{241}Am, and C. T. fractions from all organs contained measurable ^{241}Am. The ^{241}Am distribution in soft tissues of beagle dogs was related to individual characteristics of each organ and to the blood supply of that organ. (auth)

553 (COO-119-240, pp 129-38) A COMPARISON OF THE MACRO DISTRIBUTION OF ^{241}Am AND ^{59}Fe IN THE YOUNG ADULT BEAGLE. Atherton, David R.; Stover, Betsy J.; Lloyd, R. D.; Bruenger, F. W. (Utah Univ., Salt Lake City. Radiobiology Div.).

Two dogs were given 3.8 μCi ^{59}Fe/kg and, after a half hour interval, 4.5 μCi ^{241}Am/kg by intravenous injection. Each of the radionuclides was carrier free in 0.08 M citrate solution of pH 3.5. After intervals of seven and eight days the animals were anesthetized with sodium pentathol and then euthanized by exsanguination. A number of specific tissues were taken and specially treated so that distribution of the two nuclides on a subcellular basis could be undertaken. These and almost all of the remaining tissues were analyzed for retention of the two nuclides. Details of the distributions of the retained americium and radioiron are presented. ^{241}Am retentions by the skeleton, liver, and other soft tissue were about 29%, 48%, and 4% respectively while the corresponding ^{241}Am/^{59}Fe ratios were about 5, 6, and 0.15. (auth)

554 (COO-119-240, pp 139-61) ON THE BINDING OF ^{241}Am IN THE CANINE LIVER. Bruenger, F. W.; Stover, Betsy J.; Stevens, W. (Utah Univ., Salt Lake City. Radiobiology Div.).

When ^{241}AmIII in citrate buffer was injected intravenously, about half was deposited in the liver of the beagle. The liver was separated into five fractions which are connective tissue, nuclei and debris, mitochondria and lysosomes, microsomes, and soluble material. The concentration of ^{241}Am was significant in all five fractions. The soluble fraction was separated according to molecular weight, and ^{241}Am was found with the material of highest weight, of ~450,000 M.W., and of ~1500 M.W. The material of highest weight with which ^{241}Am was associated was tentatively identified as lipofuscin. The material of 450,000 M.W. was purified and identified as ferritin. The association of ^{241}Am with ferritin is of high stability. The material of ~1500 M.W., with which only a small amount of the ^{241}Am was associated, was not identified. Analysis of a digest of the microsomal fraction showed ^{241}Am bound to ferritin and to an unidentified material of high weight. The reaction AmIII-transferrin + ferritin → transferrin + AmIII-ferritin was shown to occur in vitro as is the case with PuIV. Limited results show the ^{239}Pu may also be strongly bound by ferritin in the liver of the living dog. (auth)

555 (COO-119-240, pp 162-71) FRACTIONAL WEIGHT OF THE BEAGLE SKELETON. Atherton, David R.; Stover, Betsy J.; Bruenger, F. W. (Utah Univ., Salt Lake City. Radiobiology Div.).

Weight measurements of wet and ashed partial skeletons of 11 beagles from our colony show that the average wet and ashed weights of those skeletons were 0.0723 (±13.6%) and 0.0308 (±12.6%) respectively times the animal's weight at injection. Studies of procedure showed the errors deriving from dehydration during defleshing and storage to be small. (auth)

556 BIOLOGICAL EFFECTS OF ^{241}Am. Zalikin, G. A.; Moskalev, Yu. I.; Petrovich, I. K.; Rudnitskaya, E. I. (Inst. of Biophysics, Moscow). Radiobiologiya, 9: 599-603(July-Aug. 1969). (In Russian).

The peculiarities of the distribution and biological effects of ^{241}Am-chloride after intravenous injection were studied in experiments on rats and dogs. It was established that the basic amounts of ^{241}Am were retained in the liver (57%) and bone (24%). The assimilation of the isotope from the gastrointestinal tract comprises 0.33%. In the case of treatment with acutely effective doses, the typical picture of acute radiation sickness develops. In contrast to rats, among dogs the hemorrhagic syndrome and the development of necrotically ulcerous anginas are more pronounced. In the long-term periods after intravenous injection of the isotope at doses of 0.025 to 0.0025 μCi/g, osteosarcomas arise (about 6%). (tr-auth)

557 PHOSPHORUS METABOLISM IN SPINACH CHLOROPLASTS. 1. ^{32}P INCORPORATION AND DISTRIBUTION IN VARIOUS FRACTIONS FROM ISOLATED CHLOROPLASTS. Sugahara, Kiyoshi (Kyushu Univ., Fukuoka). Mem. Fac. Sci., Kyushu Univ., Ser. E, 5: No. 1, 1-12(Dec. 1968).

The mature leaves of spinach, that were treated with ^{32}P orthophosphate in the dark by immersing the petioles in a solution containing ^{32}P, were incubated for a further period with the petioles immersed in distilled water in the dark and in the light. The distribution of ^{32}P as well as total P in various fractions of chloroplasts isolated from the leaves was studied. Lipid-^{32}P increased in the light, whereas RNA-^{32}P increased in the dark. ^{32}P of acid soluble and DNA-protein fractions showed no appreciable differ-

ence between the dark and light. No significant change in total P contents in various fractions was observed. The metabolic activity of acid soluble-P was the highest, followed by RNA-P, DNA-protein-P and lipid-P, in order. The effect of light on ^{32}P incorporation into lipid and RNA fractions was studied. Light stimulated the turnover of lipid-P and suppressed the increment of turnover of RNA-P observed in the dark. A certain compound causing metachromasy was found in the RNA fraction. The existence of inorganic polyphosphate in spinach chloroplasts was suggested. (auth)

558 PERMEABILITY OF THE HAMSTER PLACENTA TO RADIOACTIVE CADMIUM. Ferm, Vergil H.; Hanlon, David P.; Urban, John (Dartmouth Medical School, Hanover, N. H.). J. Embryol. Exp. Morphol., 22: 107-13(Aug. 1969).

The demonstration that Cd is teratogenic in the golden hamster prompted an investigation of the permeability of the early hamster placenta to radiocadmium. In addition, since Zn protects the hamster embryo from the teratogenic effect of Cd, the effect of Zn on the placental permeability to radiocadmium was examined. On the eighth day of gestation a ^{109}Cd solution, with or without Zn, was injected into the sublingual vein of the pregnant hamsters. Carrier-free $^{109}CdCl_2$ was added to 1.50×10^{-3}M $CdSO_4$ in water to yield a solution which contained 6.6 μCi/ml. In some cases the ^{109}Cd solution was also made 1.50×10^{-3}M in $ZnSO_4$. Detectable counts in the embryonic tissue at 9 days and 12 days of pregnancy indicated that the placenta is permeable to ^{109}Cd. Zinc in equimolar amounts had no significant effect on the total ^{109}Cd content of placenta and embryos at 9 days. Therefore, although the simultaneous administration of Zn will prevent the teratogenic effect of Cd, it does not prevent the placental transfer of radiocadmium. The observed relative decrease in embryonic concentration of radiocadmium on the twelfth day of gestation, 96 hr after injection, was explained as a dilution effect or an active block in placental transport, perhaps in the developing yolk sac placenta. (BBB)

559 DETECTION AND ISOLATION OF RADIONUCLIDE-ACCUMULATING BACTERIA BY AUTORADIOGRAPHY. Kokke, R.; van Zuilekom, Jeannine T.; Wiken, T. O. (Technological Univ., Delft, Netherlands). Antonie Van Leeuwenhoek J. Microbiol. Serol., 35: 121-8(1969).

A simple and rapid method for the detection and isolation of radionuclide-accumulating microorganisms is described, and was demonstrated with ^{60}Co, ^{89}Sr, ^{106}Ru, ^{131}I, ^{134}Cs, and ^{144}Ce. In the method used, water samples are mixed with the radioisotope solution and peptone agar in Petri dishes and incubated at 25°C. After bacterial colonies have appeared the agar is removed from the dish and placed upside down on x-ray film covered with thin plastic foil. Black spots on the developed radiogram reveal which surface colonies contain radionuclide-accumulating bacteria. From these colonies pure cultures are obtained by standard methods. Blackening produced by different radionuclides could not be compared directly. Furthermore, low-energy β particles were the most effective in blackening the film. A colony that has accumulated ^{106}Ru (maximum β energy = 0.04 MeV) caused more blackening than one accumulating an equivalent amount of ^{60}Co (maximum β-energy = 0.31 MeV). Among the bacterial strains isolated, 11 accumulated the radionuclide of Co, 3 Sr, 3 Ru, 3 I, 1 Cs, and 5 Ce. The isolated strains were transferred 30 times to fresh peptone agar slants. Not all strains retained the ability to accumulate nuclides. After a few transfers, ^{106}Ru strains did not accumulate it any longer. (BBB)

560 AGE AND DIET EFFECT ON THYROIDAL IODINE METABOLISM IN RATS. Kurata, Munetsugu (Tokushima Univ., Japan). Tokushima Daigaku Yakugaku Kenkyu Nempo, No. 17, 11-14(Mar. 1969). (In Japanese).

The correlation between iodine metabolism and diet intake was examined in Japanese rats. The effects of age and season (August and December) were also studied. The nutritional condition of the groups was as follows: control groups were fed ad libitum, and other groups received 70% and 40% the quantity of the controls or 40% the amount plus cellulose powder. In the low food intake groups, body weight and weight of 13 organs decreased, but thyroidal ^{131}I-amino acids were not changed significantly. In winter, however ^{131}I thyroidal uptake was increased in the treated groups. (auth)(FMM)

561 ACTIVITY OF GUANINE DEAMINASE IN THE KIDNEY, LIVER, AND BLOOD OF RATS DURING EXPERIMENTAL INTOXICATION WITH URANYL NITRATE. Bastide, Janine; Bastide, Pierre. (CNRS-INSERM, Clermont-Ferand, France). Compt. Rend. Soc. Biol., 162: 1169-71(1968). (In French).

The quanine deaminase activity was followed in the kidney, liver, and blood of the rat during experimental intoxication with uranyl nitrate. After 24 hr, there was observed a progressive increase of this activity in all the organs. In the liver, however, there was a very sharp decrease during the first 12 hr following the administration. (tr-auth)

562 5-HYDROXYTRYPTOPHAN DECARBOXYLASE AND MONOAMINE OXIDASE ACTIVITIES IN THE KIDNEYS OF RATS AND MICE AFTER EXPERIMENTAL URANYL NITRATE INTOXICATION. Bastide, J.; Bastide, P. Ann. Biol. Clin. (Paris), 26: 1239-45(Oct.-Dec. 1968). (In French).

In experimental uranyl nitrate intoxication of the rat and the mouse, a very important decrease in the renal 5-hydroxytryptophan-decarboxylase and a remarkable diminution in the renal monoamine oxydase expecially in the rat have been reported. (auth)

563 STUDIES ON THE MODE OF ACTION OF INDOLE-3-ACETIC ACID BY MEANS OF HEAVY WATER. Dahlheim, Helga (Institut fuer Stabile Isotope, Leipzig). Planta, 86: 224-34(June 3, 1969). (In German).

The influence of D_2O culture medium (99.8 at.%) on the effect of auxins in Pisum sativum and Agrostemma githago was studied. The auxin-induced cell elongation and the formation of indole-acetylaspartic acid (IAAsp) of pea epicotyl sections and Agrostemma hypocotyl sections were inhibited by heavy water. The formation of IAAsp requires a specific enzyme. The lack of IAAsp in D_2O-treated plant tissues may be due to an influence of D_2O on the induction or on the synthesis of that enzyme. Treatment of plant sections with synthetic IAAsp had no effect on the growth of the sections in D_2O. Indole-3-acetic acid (IAA) increased the incorporation of ^{32}P-orthophosphate into ribosomal and soluble RNA of pea epicotyl sections in H_2O but not in D_2O. The synthesis of ribosomal RNA was decreased by heavy water. The effects of IAA and D_2O on the soluble proteins of pea sections were studied by gel electrophoresis. Although D_2O did not change the pattern of protein bands in comparison with the H_2O control, it prevented the IAA-induced alteration of the Rf value of one protein band on the pherogram. It is suggested that the inhibition of auxin-induced reactions in a D_2O medium is due to the stabilizing effect of heavy water on allosteric proteins. The results support the hypothesis that IAA acts as an allosteric effector. (BBB)

564 STUDY OF THE VARIATIONS FOUND IN PLUTONIUM URINARY DATA. Moss, W. D.; Campbell, E. E.; Schulte, H. F.; Tietjen, G. L. (Los Alamos Scientific Lab., N. Mex.). Health Phys., 17: 571-8(Oct. 1969).

Estimation of plutonium deposition in the body by urinalysis is complicated by variations in sample collection and analysis, by normal metabolic changes, and by possible sample contamination. The variation of urinary plutonium excretion was studied in samples collected over the past 22 yr from employees who excrete detectable levels of plutonium. Special 24 hr urine samples were collected from eight employees who had been removed from plutonium exposure. The plutonium excretion rate was studied by comparing the variation found in the 24 hr samples with that found in routine samples from the same individuals and by examining the analytical recovery using ^{236}Pu tracer in each sample. Over five days the 24 hr plutonium excretion values for eight employees varied significantly less than predicted by their routine analyses. (auth) (UK)

565 THE THERMAL VOLATILIZATION OF ^{137}Cs, ^{210}Po, AND ^{210}Pb FROM IN VIVO LABELED SAMPLES. Martin, A.; Blanchard, R. L. (Bureau of Radiological Health, Cincinnati). Analyst, 94: 441-6(June 1969).

Thermal losses of ^{210}Po and ^{210}Pb from caribou bone and of ^{137}Cs and ^{210}Po from reindeer muscle were measured in the temperature range 100° to 1000°C. Polonium was partly volatilized at all temperatures above 100°C, although from bone, the loss was small below 200°C. Negligible amounts of ^{210}Rb were lost from bone samples heated below 600°C, but losses from muscle were observed to occur above 150°C. To avoid losses of ^{137}Cs, muscle samples should not be heated above 300°C. (auth) (UK)

566 ION ABSORPTION IN ATRIPLEX LEAF TISSUE. II. SECRETION OF IONS TO EPIDERMAL BLADDERS. Osmond, C. B. (Australian National Univ., Canberra); Luttge, U.; West, K. R.; Pallaghy, C. K.; Shacher-Hill, B. Aust. J. Biol. Sci., 22: 797-814(Aug. 1969).

The epidermal bladders of several Atriplex species contain high concentrations of ions. Chloride was secreted from the solution or the lamina to the bladders, against a concentration gradient. Transfer of ^{36}Cl to the bladders was strongly light stimulated, but uptake to the lamina was much less sensitive. Electrical potential measurements showed that the vacuole of the bladder cell was highly electronegative with respect to the bathing solution. Switch-

ing from dark to light and vice-versa resulted in transient changes in potential. In some instances the potential settled to a level which was more negative in the light than in the dark. These observations suggest that uptake of chloride into the bladders is an active process. Autoradiographs of intact and sectioned bladders after exposure to $K_2{}^{36}SO_4$ and $K^{36}Cl$ showed that radioactivity was concentrated in the stalk cell and peripheral cytoplasm of the large vacuolated bladder cell. Electron microscopy showed that the stalk cell and peripheral cytoplasm of the bladder cell contained chloroplasts, numerous mitochondria, much endoplasmic reticulum, and many small vesicles. The stalk cell has the submicroscopic characteristics of a salt gland and, it is connected to the bladder cell and the epidermal cells by plasmodesmata, may secrete ions from the leaf symplasm to the bladder cell. (Australia)

567 TRANSPLACENTAL PASSAGE OF ACTIVATION AND FISSION PRODUCTS. Legare, Jean-Marc (Ministere de la Sante du Quebec, Montreal). Hospital (Rio de Janeiro), 74: 687-98(Sept. 1968). (In French).

The physiological functions of the placenta are outlined and the methods available for the study of transplacental passage of radioactive elements are summarized. The experimental results obtained from placentary perfusion in guinea pigs after 50 days of gestation are reported. The radioactive elements used were ^{125}I, ^{131}I, ^{45}Ca, and ^{137}Cs. The results showed a preference for the placental transfer of K with respect to ^{137}Cs. In the guinea pig the passage in the mother-fetus direction was high for calcium and iodine. The extraction percentage for the fetus-mother return in the guinea pig was 30% for Cs, Ca, and I. The mother-fetus extraction percentage for iodine was higher than for ^{45}Ca and ^{137}Cs. Previous data on the transplacental passage of Fe, Zn, and inorganic phosphates were also summarized. (J.S.R.)

568 MEASUREMENT OF THE APPARENT INTESTINAL ABSORPTION OF CALCIUM IN THE RAT, USING RADIOACTIVE CHROMIUM CHLORIDE AS A LABEL. Cuisinier-Gleizes, P.; Desbuquois, B.; Mathieu, H. Rev. Fr. Etud. Clin. Biol., 13: 398-404(Apr. 1968). (In French).

The purpose of the present study is: to test the assumption that transit time through the intestine is the same for Ca and ^{51}Cr ingested as $^{51}CrCl_3$; to measure the net absorption coefficient of Ca by the Ca/^{51}Cr ratio technique in normal rats. In the first case, four rats received orally one dose of ^{51}Cr and ^{45}Ca. Samples of feces were collected the five following days; ^{51}Cr and ^{45}Ca were estimated in each case. Each concentration of ^{45}Ca was plotted against each concentration of ^{51}Cr. The nearness of correlation coefficient to unity supports the assumption that ^{51}Cr ingested as $^{51}CrCl_3$ and ^{45}Ca have the same passage time through the intestine. In the second case the net absorption coefficient of Ca was measured on 17 rats using $^{51}CrCl_3$ as reference substance. The findings are not different from those that were obtained by other authors using other methods. The conclusion was that this method using $^{51}CrCl_3$ as reference substance has the same accuracy as the other methods and the obvious advantage of being easy. (auth)

569 ON THE EXCHANGE OF ^{90}Sr AND ^{45}Ca IN THE ORGANISM DURING HYPERCALCEMIA. Dubrovina, Z. V. (Inst. of Biophysics, Moscow). Radiobiologiya, 8: 684-8(1968). (In Russian).

The dependence of the deposition of radioisotopes in the bone upon the amount of introduced Ca and upon the actual Ca content in the blood was studied in an experiment on rats with intravenous injection of stable Ca, ^{45}Ca, and ^{90}Sr. The phenomenon of dilution of radiostrontium incorporated into the bone by serum calcium was discovered. Data were obtained indicating a stability of the exchange pool of Ca in the bone. The value of the exchange pool of Ca in the skeleton and the rate of accretion were calculated. (JPRS)

570 STRENGTH OF FIXATION OF ^{90}Sr AND ^{137}Cs BY LIVING AND DEAD TISSUES OF FRESH WATER PLANTS. Kulikov, N. V.; Lyubimova, S. A.; Timofeeva, N. A. (Inst. of Ecology of Plants and Animals, Sverdlovsk, USSR). Radiobiologiya, 8: 760-3(1968). (In Russian).

The elimination of ^{137}Cs and ^{90}Sr by living and dead tissues of three species of fresh water plants (Cladophora, moss, and hornwort) was studied under experimental conditions. It was established that both radioisotopes are eliminated comparatively easily from a dead plant substrate and with somewhat greater difficulty (especially ^{137}Cs) from living plants. The data obtained reveal the predominant role of exchange mechanisms of the fixation of strontium and cesium both in living and in dead plants. (JPRS)

571 INFLUENCE OF THE BINDING OF ^{90}Sr, ^{91}Yb, AND ^{137}Cs BY BLOOD SERUM PROTEINS ON THEIR ACCUMULATION IN THE TISSUES. Lyubashevskii, N. M. (Inst. of Evolution of Plants and Animals, Sverdlovsk, USSR). Radiobiologiya, 8: 754-5(1968). (In Russian).

Data on the ultrafilterability of ^{91}Y, ^{90}Sr, and ^{137}Cs from serum and an 8% solution of albumin and their retention in the tissues during perfusion of these protein solutions to the vascular system of rat limbs were compared. A high correlation (0.86 to 0.99) was found between the content of the free isotope in the serum and protein solution and its accumulation in all the extremities, bones, and soft tissues. Results were expressed in percent of accumulation by the corresponding tissue. Proteins of the perfusate influence the deposition of radioisotopes in the soft tissues to a greater degree than in the bones of the limbs. (JPRS)

572 INFLUENCE OF THE CALCIUM LEVEL IN THE DIET ON THE ACCUMULATION OF ^{90}Sr IN CALVES DURING THE EMBRYONIC AND POST-EMBRYONIC PERIODS OF DEVELOPMENT. Filippova, V. N.; Soldatenkova, L. I.; Seits, I. F. Radiobiologiya, 8: 752-3(1968). (In Russian).

In chronic experiments on pregnant cows, kept on diets with various calcium levels, its influence upon the accumulation of ^{90}Sr in the bodies of eight- and nine-month fetuses and newborn calves was demonstrated. Thus, in the group of fetuses and newborn calves, the mothers of which received 18 to 23 g of calcium, the accumulation of ^{90}Sr in the skeleton was 1.12 to 1.13% of the amount taken in, while for fetuses and calves from cows that received 46 to 52 g of calcium, the accumulation of ^{90}Sr was 2.1 to 2.4 times lower. Eighteen calves were kept from their day of birth up to 6, 12, and 25 months of age on diets with two calcium levels. It was shown that increasing the calcium in the diet of the calves from 8 to 18 to 22 g lowers the deposition of ^{90}Sr in their skeletons at the ages of 6, 12, and 25 months by 1.3, 1.2, and 1.8-fold, respectively. (JPRS)

573 RADIOAKTIVNYE IZOTOPY I ORGANIZM. (Radioactive Isotopes and Organism). Moskalev, Yu. I. (ed.). Moscow, Izdatel'stvo Meditsina, 1969. 391p.

The results of experimental investigations on the distribution and kinetic exchange of ^{137}Cs, ^{90}Sr, ^{45}Ca, ^{144}Ce, ^{132}I, ^{239}Pu, ^{210}Po, ^{46}Sc, ^{99}Mo, ^{233}Pa, ^{241}Am, ^{54}Mn, ^{198}Au, and ^{238}U are given. The biological action of ^{90}Sr, ^{239}Pu, ^{106}Ru, ^{233}Pa, ^{131}I, ^{144}Ce, and ^{3}H, is discussed in terms of the treatment and the prophylaxis of damage caused by these dangerous and important radioactive nuclides. The merit of the monograph is that it analyzed not only this literature, but also led to many new facts that are the results of original investigations of these questions. Among the new facts, attention is directed to the accumulation of radioactive isotopes in organs and tissues of animals under conditions of prolonged residence of radioactive nuclides in the organism. The estimate of the standard dose of ^{90}Sr to the population was given. It showed that such quantities did not create irradiations above the maximum permissible level in all age groups determined including young children. Data concerning the distribution and the kinetic exchange of radionuclides in animals (sheep, hogs, goats, calves, and cows) and in chickens are given showing that the transuranic element ^{241}Am upon perenteral injection is selectively retained in liver and skeleton. The question of the biological action of radioactive isotopes is discussed with the action of ^{233}Pa of primary concern. Results are given concerning the specific nature of action of radioactive isotopes in relation to dose, properties, pathways, and incidence of isotopes in organisms. Attention is given to the latent consequences, the effect of additional factors on late reactions of the organism, and also to the question of pathogenesis. Information concerning the effect of ^{90}Sr and ^{3}H on the fertility and development of rats and mice is presented. The characteristics of kinetic exchange and the biological action of the radioactive isotopes in relation to ionizing properties dose configurations, pathways, and cycles in organisms are also discussed. (tr-auth)

574 ASSIMILATION, RETENTION, AND ELIMINATION OF ^{90}Sr AND ^{45}Ca FROM THE RAT ORGANISM WHEN THE CALCIUM METABOLISM IS DISTURBED. Malkina, R. M. (Inst. of Biophysics, Moscow). Radiobiologiya, 8: 693-9(1968). (In Russian).

Intact rats and rats that were made hypercalcemic and calciurimic by the administration of 80 units of Parathormone were used to study the assimilation, deposition in the tissues, and elimination of ^{45}Ca and ^{90}Sr administered orally and parenterally. Results indicated that a disturbance of calcium metabolism produced by the administration of Parathormone does not affect ^{90}Sr/^{45}Ca ratios of assimilation from the intestine, the skeleton, blood, muscles, or excreta of the experimental rats. (JPRS) (TSS)

575 MECHANISM OF ABSORPTION OF ALKALINE EARTH ELEMENTS BY BONE TISSUE. Mikhailova, A. I. Radiokhimiya, 11: 360-2(1969). (In Russian).

Results of a study of the kinetics of the absorption of Ca, Sr,

Ba, and Ra are given in tabular form. The absorption of alkaline earth elements into the solid phase ended in about 50 hr. It was found that the absorption occurs by three processes and premises were made concerning the character of these processes. The most rapid process, probably, reflects the movement of the ions into the hydrate shell of crystals of bone material. Then there is an exchange between the ions and the calcium connected to the phosphate group, followed by an exchange with calcium attached to the hydroxyl group. (tr-auth)

576 COMPARATIVE METABOLISM OF ^{137}Cs BY ADULT, SUCKLING, AND PRENATAL RATS. Mahlum, D. D.; Sikov, M. R. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Comp. Biochem. Physiol., 30: 169-75(1969).

The placenta presented a substantial barrier to the free passage of ^{137}Cs from the dam to the fetus in the rat as evidenced by the accretion of ^{137}Cs in the placenta and by the substantially lower concentration in the fetus relative to the dam. Several aspects of ^{137}Cs metabolism differed according to the age of the animal at the time of administration. The rate of loss of ^{137}Cs was initially lower in the early neonate than in the adult, but subsequently increased to a value much larger than for the adult. The relative distribution of the radiocesium among various tissues changed with time after administration and differed significantly between the neonate and mature animal. (auth)

577 RADIOARSENIC LABELING OF CHROMIUM COMPOUNDS. Anghileri, L. J. (Johns Hopkins Medical Institutions, Baltimore). Int. J. Appl. Radiat. Isotop., 20: 738-42 (Oct. 1969).

The feasibility of tagging various chromium compounds with radioarsenic to facilitate their use in diagnosis and therapy was evaluated. The basis of this tagging is the property of many anions to replace some of the water molecules in the chromic-hexaaquo complex ion ($Cr(H_2O)^{6+3}$) by a process termed anion penetration. In order to determine the degree of change caused by the incorporation of the anionic radioarsenic, studies of the physico-chemical and biological properties were undertaken. The compounds studied were $^{74}AsCrPO_4$ (particulate), $^{74}AsCrPO_4$ (colloidal), ^{74}AsCr-albumin and ^{74}AsCr-β-glycerophosphate. The yield of labeling was 70 to 80%; 40 to 60%; 70 to 90% and 95 to 99%, respectively. Results of experiments on mice show that radioarsenic incorporated into insoluble chromium compounds presents very high stability in vivo. When radioarsenate is covalently bound to a soluble form of chromium it may be partially displaced, but less than 10% is released in vivo. From the biological point of view, the tag behaves in the identical way as the original chromium derivatives. Whole body counting (uptake and excretion) and body distribution are completely similar to those of $^{51}CrPO_4$, ^{51}Cr-albumin and ^{51}Cr-β-glycerophosphate. (UK)

578 SEX DIFFERENCES IN BLOCKING THYROID RADIOIODINE UPTAKE IN MICE. Schreiberova, O.; Kapitola, J. (Charles Univ., Prague). Experientia, 42(Jan. 15, 1969).

A significant difference was observed in the uptake of ^{131}I by the thyroid gland of male and female mice following ingestion of desiccated thyroid gland. No significant difference was observed, however, in the blocking effects of daily doses of thyroxine on ^{131}I uptake by the thyroid gland of male and female mice. In a third experiment where thyroxine was administered 6 days prior to ^{131}I administration, female mice consistently concentrated larger amounts of ^{131}I in the thyroid gland. It was concluded that females concentrate ^{131}I in the thyroid gland to a greater extent than male mice, and that the administration of thyroid hormone influences concentration in both sexes. (E.R.B.)

579 UPTAKE AND METABOLISM IN VIVO OF TESTOSTERONE-1,2-^{3}H BY ACCESSORY SEX ORGANS OF MALE RATS; INFLUENCE OF SOME HORMONAL COMPOUNDS. Tveter, Kjell J.; Aakvaag, Asbjoern (Rikshospitalet, Oslo. Aker Sykehus, Oslo). Endocrinology, 85: 683-9(Oct. 1969).

A study was made of the influence of certain hormones and synthetic hormonal compounds on the uptake of radioactivity by rat seminal vesicles and prostate gland following the administration of testosterone-1,2-^{3}H in vivo. Androstenedione, 17α-methyltestosterone, 17α-methyl-β-nortestosterone (SK&F 7690), progesterone, and corticosterone reduced the uptake of radioactivity. 17β-Estradiol and diethylstilbestrol did not reduce the uptake; indeed, in the lateral prostate an increased accumulation of radioactivity was observed. One hr after administration of testosterone-^{3}H, unchanged testosterone represented 3.0 to 17.1% of the total radioactivity in the accessory sex organs. 5α-Androstan-17β-ol-3-one was the main metabolite, constituting about 70% of the total radioactivity. (auth)

580 METABOLISM AND RADIATION HAZARD OF ORALLY INGESTED TRITIATED THYMIDINE. Wade, Leo Jr. Lawrence, Kan., Univ. of Kansas, 1968. 63p.

Thesis.

The uptake, distribution, and retention of orally ingested tritiated thymidine (^{3}HTdR) was measured in the mouse as a first step in assessing the hazard to man. A comparison was made between the metabolism of one microcurie and ten microcuries of total activity. A comparison was also made between subcutaneous injection and lavage as routes of burdening. Male albino mice were given one microcurie ^{3}HTdR by lavage, ten microcuries by lavage, or one microcurie by subcutaneous injection. At 1, 2, 4, 8, 16, 30, and 60 days after burdening, three mice in each series were sacrificed. The organs to be tested were removed and weighed. Half of each organ was immediately digested. The other half was frozen, lypholized, and then digested. The total radioactivity and non-volatile radioactivity were determined for each tissue. The radiation dose to the nuclei of the cells in each tissue was calculated, assuming that all non-volatile activity was in the nucleus. The excretion curves of non-volatile activity for all tissues had two components. One had a half-time of 3.5 days. The slower component had a half-time of several weeks. Highest levels were seen in the spleen, liver and small intestine. Lower, but significant, levels were seen in the testis, kidney and muscle. Subcutaneous injection produced higher levels of activity than oral ingestion in the intestine, spleen, and testis, but the rates of excretion were not different. No significant difference was seen in the levels of activity in the kidney, liver, and muscle. The metabolism of ten microcuries of ^{3}HTdR given by lavage was not significantly different from one microcurie through the first 4 days after burdening, but after 8 days, the rate of decrease of non-volatile tissue activity was significantly greater for the mice given ten microcuries. This was interpreted to represent a radiation effect, even though the maximum radiation dose to the nuclei of these tissues was probably not greater than 15 Rads. The data in this study led to the following conclusions: there is significant incorporation of tritiated thymidine into the DNA of all tissues of the mouse after oral ingestion; at least part of this incorporation is not related to mitotic activity; subcutaneous injection produces greater non-volatile tissue activities in proliferative tissues than does oral ingestion; a radiation effect is produced by levels of tritium activity that deliver a radiation dose to the nucleus that is not greater than 15 Rads; a single oral ingestion of 0.2 mCi or less of tritiated thymidine by man could deliver a radiation dose of 1.25 Rads over a 13 week period to the nuclei of a significant fraction of cells in the total body. (auth)

581 USE OF CITRATE IN MOBILIZING PLUTONIUM IN THE RAT. Smith, H. (Sunderland Polytechnic, Eng.). Nature (London), 223: 642-3(Aug. 9, 1969).

Experimental work is described with a view to evaluating the use of citrate in the treatment of acute Pu poisoning and the possibility of extrapolating the data to humans. Rats were given an intraperitoneal injection of a solution containing ^{239}Pu and ^{237}Pu in 0.1M citrate at pH 7; the predominant Pu species was 4-valent. The animals received a similar injection of 730 mg citrate (as trisodium citrate) per kg body weight either before, during, or after Pu injection. Urine and faeces were assayed by measuring the 100 keV x-rays from ^{237}Pu. The maximum effectiveness was obtained when citrate was given simultaneously with the Pu, followed by a second injection after 90 min. Effectiveness fell off if citrate therapy was delayed, but it was of some value up to 24 hr. Citrate injected 30 min before Pu administration was of no value, presumably because of its rapid transfer, metabolism and excretion. Preferential Pu excretion in urine was apparent in the initial two day period following citrate administration. Studies were also made on the influence of citrate on the tissue distribution of Pu in the immediate post-injection period. During this 3 hour period there was a more rapid transfer of Pu from the peritoneal cavity, an enhanced urinary excretion and a marked retention in liver in the citrate treated group compared with controls; there was, however, no difference in amount of Pu transferred to bone. There was little toxic action from trisodium citrate. (UK)

Radiation Effects

Refer also to abstracts 133, 230, 751, and 918.

582 (AD-689095) KREBS CYCLE DEHYDROGENASE SYSTEMS ACTIVITY IN THE GASTROINTESTINAL TRACT OF RATS AFTER WHOLE-BODY IONIZING IRRADIATION. Kivy-Rosenberg, E. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Apr. 1969. 31p. (AFRRI-SR-69-6). CFSTI.

Using a tetrazolium salt, three of the Krebs cycle dehydrogenase systems were studied in homogenates of four regions of the gastrointestinal tract of the rat following either x rays or mixed gamma-neutron radiation delivered to the whole body (WBR). Microchemical assays were done at intervals after irradiation (10 to 20 minutes, 1, 2, and 3 days). There was a fall in activity as early

as 10 to 20 minutes postirradiation that increased in magnitude by the second and third day, for all regions studied. The gamma-neutron irradiations were relatively more effective than were the x rays in bringing about this depression in malate-, succinate- and isocitrate-dependent dehydrogenase activity. The activity of the three assayed Krebs cycle dehydrogenase systems in the regions of the gastrointestinal tract studied was shown to be below normal after exposure to WBR. The functional capacity of the Krebs cycle appears impaired that may account, in part, for some of the functional derangements seen in such animals. (auth)

583 (AD-689096) EFFECT OF X RAYS AND ^{60}Co GAMMA RAYS ON THE LIVER ENZYME SYSTEM RESPONSIBLE FOR FATTY ACID SYNTHESIS. Catravas, G. N. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Apr. 1969. 22p. (AFRRI-SR-69-7). CFSTI.

The effects of in vivo exposure to x rays and ^{60}Co γ rays on the fatty acid synthesizing liver enzyme system are described. Both fed and fasted young female Sprague-Dawley rats were utilized in the experiments. All irradiated animals received a single whole-body exposure of 1200 R at 20 R/min. The irradiated animals as well as sham irradiated controls were sacrificed at predetermined times after exposure and cell-free liver homogenates, that contained the enzyme system under investigation were prepared. It was found that the activity of the liver enzyme system responsible for the biosynthesis of fatty acids is greatly stimulated by x or ^{60}Co γ rays and that the cytoplasmic soluble enzymes are affected by radiation to a much greater extent than the mitochondrial enzymes. Blood glucose determinations were carried out in irradiated and control rats as well as in rats that were made alloxan diabetic. The results indicate that the enhancement of enzyme activity observed is not due to an increase in the blood glucose level of the animal as a result of exposure to radiation but to some other factor the nature of which has not yet been elucidated. (auth)

584 (COO-1603-3) EFFECTS OF TRITIUM DECAY ON DNA. Terminal Summary Report. Martin, Rachmeler (Northwestern Univ., Chicago, Ill. Dept. of Microbiology). Sept. 30, 1969. Contract AT(11-1)-1603. 6p. Dep. CFSTI.

The major products of ^{3}H decays in Escherichia coli cells are ion pairs. These in turn react with the DNA, and other macromolecules of lesser importance for the effects noted, to cause strand breaks, very likely the phosphodiester bond. Cell death is probably caused by one of these breaks or a double strand break produced as a result of a single decay. It appears that not all decays lead to DNA strand breakage. DNA repair mechanisms tend to decrease the efficiency of ^{3}H decays in causing cell death. The decays of $^{3}H-CH_3^-$ thymidine are poorly mutagenic and cause no rupture of bonds between base and sugar or sugar and phosphate. In addition there appear to be no long range effects along the length of the chromosome as determined by the lack of effect of randomly occurring decays on the transcriptional ability of three independent cistrons not closely linked. The quantitative relation between ^{3}H-decays and strand breakage is now being determined. (auth)

585 (N-69-31619) SOLVENT EFFECTS IN THE RADIATION DEGRADATION OF DNA SOLUTIONS. Blackman, Carl F. Jr. (Pennsylvania State Univ., University Park. Dept. of Biophysics). June 1969. 86p. (NASA-CR-103301). CFSTI. Thesis.

Calf thymus DNA was prepared in three solvents and irradiated at 77°K for a series of doses and concentrations with ^{60}Co γ rays. Alkali and neutral band sedimentation was used to obtain initial molecular weight distributions and the molecular weight of both single and double strand samples at each dose. This information was then converted to the number of molecular scissions per molecule by an equation for random scissions. The damage to DNA irradiated at 77°K and warmed to room temperature for analysis was enhanced when phosphate was present; this enhancement was attributed, in part, to indirect radiation action. Differences in the rates of single strand break production were attributed to solvent modifications of radiation action. The double strand break production could be interpreted as resulting from an accumulation of single strand breaks and from directly-produced double strand breaks that occurred when a sensitive core (approximately three angstroms in diameter) was hit. (auth) (STAR)

586 (NYO-910-122) BIOLOGICAL EFFECTS OF RADIATION AND RELATED BIOCHEMICAL AND PHYSICAL STUDIES. PROPOSAL NO. 2. 1. RADIATION MECHANISMS IN MAMMALIAN SYSTEMS. 2. CHEMICAL SENSITIZATION TO RADIATION LETHALITY. Progress Report, May 1, 1968-May 1, 1969. Laughlin, John S.; Moroson, Harold; Djordjevic, Bozidar (Sloan-Kettering Inst. for Cancer Research, New York). Sept. 30, 1969. Contract AT(30-1)-910. 8p. Dep. CFSTI.

Repair mechanisms in HeLa cells in synchronous cultures exposed to x or uv radiation were investigated. Data are presented on the effects of x radiation on the activity of thymidine kinase and the structure of DNA during the division cycle; the effects of uv radiation on S-phase DNA synthesis; the effects of acriflavine on the synthesis of DNA; and the effects of thymidine on the repair of radiation damage. (C.H.)

587 EFFECTS OF WHOLE-BODY IRRADIATION ON NAD NUCLEOSIDASE IN RAT TISSUES. Ishikawa, Hajime (Tokyo Univ.). J. Fac. Sci. Univ. Tokyo, Sect. IV, 11: 465-73(Dec. 10, 1968).

Effects of x irradiation on nicotinamide adenine dinucleotide (NAD) nucleosidase (NADase) activity of rat liver and spleen were followed up to 28 hr after whole-body irradiation with 1000 R. The activity of spleen NADase showed a slight decrease during the first 4 hr, but increased progressively up to 16 hr, after which time the activity gradually decreased. The change in the activity of liver NADase was not as marked, showing a slight increase between 8 and 16 hr after irradiation. After whole-body irradiation, a marked change in the Michaelis constant (Km) was invariably observed as regards spleen NADase, although the Km of liver NADase little affected the same 1000-R dose. When a partially purified preparation of spleen NADase was irradiated with various doses of x rays, a slight but significant activation was observed, although no such effect of irradiation was found with partially purified liver NADase. Incubation of liver NADase with p-chloromercuribenzoate (PCMB) at 0°C caused a slight activation when the final concentration of PCMB was less than 0.1 mM. The activity of spleen NADase was affected only slightly under the same conditions. (BBB)

588 INFLUENCE OF AMINOETHYLPHOSPHORIC ACID ON IN VITRO INCORPORATION OF ^{32}P IN BRAIN PHOSPHOLIPIDS. Dana, Regine; Douste-Blazy, Louis (Centre Anticancereux, Toulouse). Compt. Rend., Ser. D, 268: 185-7(Jan. 6, 1969). (In French).

2-Aminoethylphosphoric acid, added to the biosynthesis medium of phospholipids in the presence of brain sections and $Na_2H^{32}PO_4$ was not incorporated in the form of phosphonolipids but impeded the utilization of ^{32}P in the synthesis of phosphatidic acids, phosphatidylethanolamines, and phosphatidylserines. (tr-auth)

589 STIMULATION OF THYROID GLAND BY HORMONES IN ACUTE THYROID DISEASE. Busnardo, B.; Accordi, F.; Debiasi, S. (Univ., Padua). Acta Isotop., 8: 165-79(Oct. 30, 1968). (In Italian).

The serum LATS level was assayed, by a modification of the McKenzie method, in 36 subjects with hyperthyroidism, 16 of them affected by thyrotoxicosis without exophthalmos and 20 by Graves disease; and furthermore in eight subjects with ophthalmic Graves disease, in three with pretibial mixoedema, in two hypothyroid, and in one patient affected by sub-acute thyroiditis. Significant LATS levels were detected in about 50% of the hyperthyroid samples of serum studied and only in 28% of the serum samples of the patients with ophthalmic Graves disease. All the patients with pre-tibial myxoedema showed very high LATS levels whereas neither the hypothyroid patients nor those with subacute thyroiditis had detectable LATS in their serum. No consistent relationship was found between serum LATS and the rate of radioiodine turnover, neither between LATS and exophthalmos nor between LATS and antithyroglobulin antibodies. These findings support the absence of clear correlation between serum levels of LATS and the main clinical features of the disease, and also between LATS and severity of hyperthyroidism. LATS was, on the contrary, found more frequently than usual in the sera of the subjects treated with radioiodine, either still hyperthyroid, or definitely recovered. (auth)

590 PHOTOELECTRIC RESPONSES OF LIPID MEMBRANES. Kay, Robert E.; Chan, Hakchill (Philco-Ford Corp., Newport Beach, Calif.). Radiat. Res., 40: 177-92(Oct. 1969).

Thin lipid membranes formed in aqueous solution from chloroform-methanol solutions of α-tocopherol or α-tocopherol plus sphingomyelin or sphingomyelin in decane gave photoelectric responses to μwatt energies of ultraviolet (uv) light of up to 160 mV and 1600 pA. The performance of all membranes was enhanced by placing an iodide solution on one side of the membrane. The location of the iodide solution was important in regard to the response obtained and specific differences were seen with membranes having different compositions. The action and absorption spectra of the membranes were determined, the effect of reversing the light direction ascertained and the current-voltage characteristics of the membranes examined before, after and during exposure to uv radiation. From data obtained it was hypothesized that changes in the membrane induced by uv radiation were an important part of the mechanism leading to the photoelectric effect. (auth)

591 STRUCTURE AND PROPERTIES OF RAT THYMUS DEOXYRIBONUCLEOPROTEIN: EFFECTS OF X-IRRADIATION. Itzhaki, Ruth F. (Cambridge Univ., Eng.). Radiat. Res., 40: 93-104(Oct. 1969).

The effects of x-irradiation on deoxyribonucleoprotein (DNP) have been studied by the method of electric birefringence (which gives information primarily about molecular size), by centrifugation, and by measuring the solubility properties. It was found that doses of several tens of kRad caused degradation of the DNP — the percentage change decreasing with increasing concentration — suggesting that the effect was mainly indirect. The degradation process continued for at least 24 hours after irradiation. Relatively low doses of about 1 kRad caused apparently a decrease in cross-linkages between the DNP particles. This effect was mainly direct. Thiourea and sodium cyanide prevented both the initial degradation effect and the after-effect when added to DNP before irradiation but not when added after irradiation. Dissociation of the DNP into the constituent DNA and protein, and breakage of the DNP into small, acid-soluble fragments, occurred to a small extent after doses of several tens of kRad delivered to solutions at low concentrations. (auth)

592 MECHANISM OF DEOXYCYTIDINURIA IN IRRADIATED MICE AND RATS. Gerber, G. B.; Remy-Defraigne, J. (Nuclear Energy Study Center, Mol, Belg.). Radiat. Res., 40: 105-11(Oct. 1969).

Deoxycytidine-2-^{14}C was injected into rats or mice and the animals were subjected to total body irradiation 1 day later. DNA in organs and metabolites in urine were isolated and their activity determined. Radioactivity in lymphoid organs decreased, whereas the total and specific radioactivity of the deoxycytidine excreted increased on the first day after exposure. This observation indicates that deoxycytidine excreted after irradiation originates from degraded DNA, since the specific activity should decrease if precursors not utilized for DNA syntheses were the main contributors to deoxycytidinuria. Experiments in which ^{14}C-deoxycytidine was given after exposure confirmed this assumption. (auth)

593 PHOTOSENSITIZING EFFECT OF CATIONS ON AMINO ACIDS AND PEPTIDES. Bogdanova, N. P.; Khenokh, M. A. pp 141-8 of Life Sciences and Space Research VII. Vishniac, W.; Favorite, F. G. (eds.). Amsterdam, North-Holland Publishing Co., 1969.

From 11th Plenary Meeting, Tokyo, Japan. See CONF-680530-(Vol.7); From Symposium on Biological Effects of Radiation in Space, Tokyo, Japan. See CONF-680555.

In connection with a study of the chemical evolution of abiogenically synthesized organic compounds on primitive Earth and the physical conditions of other planets, this paper reports the experimental results obtained by the photolysis of solutions of aliphatic amino acids (glycine, alanine, valine, leucine, and n. leucine) and peptides in the atmosphere of the air, N_2, Ar, and CO_2 in the presence of the most simple photocatalyzers-cations of sulfates. The evidence shows that the photochemical conversion of NH_2 acids depends on the content of the atmosphere. The decay of NH_2-group is most active in air. N_2 and Ar exert no significant influence on deamination, whereas in the atmosphere of CO_2 the formation of ammonia in valine, for example, was only 29% of its total amount during photolysis in the air. Cu^{2+} and Fe^{2+} catalyzed while Al^{3+} inhibited the ammonia excretion. The formation of acetaldehyde during alanine photolysis was actually independent from the atmosphere of N_2 and was inhibited in Ar and CO_2. Oxidative processes inducing the formation of glyoxalic acid and formaldehyde were sharply inhibited in Ar, N_2 and CO_2. Under the influence of ultraviolet light the decay of NH_2-acids is also accompanied by the formation of new NH_2-acids. The photosensitizing effect of cations induces a rupture of $-CO-NH-$ bonds in peptides and, provided heavy radiation doses, prevents the formation of new NH_2-acids. The longer the dipeptide chain, the more significant the quantum yield of its decomposition. The photolysis of dipeptides, leading to their decay, does not necessarily induce a hydrolytic rupture of $-CO-NH-$ bonds resulting in the formation of three amino acids. The results obtained permit approaching problems concerning the effect of the gas content of the atmosphere and various cations (photocatalyzers) on photolytic conversion of abiogenically synthesized and biogenically significant substances, amino acids for example, at the action of ultraviolet light. (auth)

594 RELATION OF DNA DEGRADATION TO THE REPAIR OF RADIATION INJURY BY L CELLS. Dalrymple, Glenn V.; Sanders, J. L.; Baker, Max L.; Wilkinson, K. P.; Walls, R. A. (Univ. of Arkansas, Little Rock, Veterans Administration Hospital, Little Rock, Ark.). Radiat. Res., 40: 112-23(Oct. 1969).

Experiments with bacteria suggest that extensive DNA degradation is an important step in the repair of radiation injury. Because of the potential importance, similar experiments with cultured mammalian cells were performed. L cells prelabeled with ^3HTdR were suspended in medium and irradiated with doses of 0, 100, 500, and 1000 Rads of 250 kVp x rays. The results showed: no massive DNA degradation occurred during the first 6 postirradiation hours; although a small amount of radioactivity is released into the suspending medium, this is not increased by increasing dose of radiation; the release of the radioactivity occurred in the presence of 2,4-dinitrophenol, an uncoupler of aerobic oxidative phosphorylation; most of the released radioactivity was in the form of thymidine; and the intracellular concentrations of alkaline deoxyribonuclease and DNA polymerase were not increased after irradiation. (auth)

595 EFFECT OF 19S ALPHA-2 GLOBULIN FROM HUMAN SERUM ON THE HEMOGLOBIN CONTENT OF BONE MARROW OF IRRADIATED MICE. Burger, M.; Knyszynski, Ahuva (Weizmann Inst. of Science, Rehovoth, Israel). Radiat. Res., 40: 203-12(Oct. 1969).

The increased level of hemoglobin in the bone marrow of mice, appearing after irradiation, is reverted by 19S alpha-2 globulin toward the normal level. The optimal conditions for this effect were found to be similar to those which produce stimulation of the regeneration of the thymus in irradiated mice. Injection of syngeneic bone marrow cells into irradiated mice produces a similar reversal of the increased level of hemoglobin in mice. A possible correlation between this effect of 19S alpha-2 globulin and its ability to regenerate irradiation damage in the bone marmor and thymus of mice is discussed. (auth)

596 AUTORADIOGRAPHIC STUDY OF THE EFFECT OF ESTRADIOL AND IRRADIATION ON NUCLEIC ACID METABOLISM OF THE THYMUS AND LYMPH NODE OF MICE. Thompson, John S.; Severson, Charles D.; Reilly, Richard W. (Univ. of Chicago). Radiat. Res., 40: 46-62(Oct. 1969).

Autoradiographs of UR-5-^3H and TdR-CH_3-^3H incorporation in the thymus and lymph node have been prepared at intervals from mice after 150 R or 0.5 mg estradiol. Epithelial reticular cells were the primary site of increased incorporation of UR-5-^3H 8 hours postirradiation. At the time of maximum incorporation 72 hours after x-ray, however, transitional cells were heavily labelled. The sequential changes in UR-5-^3H labelling in the estradiol-treated thymus were qualitatively similar though quantitatively less striking and no significant change occurred in the lymph node after either agent. The possible role of enhanced RNA synthesis in epithelial reticular cells is discussed in the relationship to the subsequent recovery of thymic lymphocytes. TdR-CH_3-^3H labeling in the thymus virtually ceased after x-ray and markedly decreased after estradiol. Reappearance first occurred in perivascular transitional cells and was followed by incorporation into the recovering lymphocyte lineage. The same general pattern occurred in the lymph node after irradiation but not after estradiol. The failure of TdR-CH_3-^3H to label epithelial reticular cells is considered to be an important point against the concept that they are the progenitors of thymic lymphocytes. (auth)

597 NEW ASPECTS ON RADIATION EFFECTS ON ERYTHROCYTES. Gerhardt, P. (Univ., Tuebingen, Ger.). Radiol. Aust., 18: 239-43(1968). (In German).

The examinations show that ionizing rays are effective on erythrocytes with much lower doses than expected. It is assumed that the increased formation of interior bodies during the Heinz body test occurs in these erythrocytes in which there is also metabolism inactivity caused by age. The decrease of reduced glutathione and associated enzymes leads to less protection of hemoglobin against oxygenating substances and to denaturation of hemoglobin. The glutathione content and enzymatic activity is normally reduced in the older erythrocytes and therefore an additional reduction by radiation can be proven only with difficulty. The cause for the increase of interior body formation during the Heinz body test in cases with professional or therapeutic radiation exposure may be an oxygenation of essential SH-groups in these cells, a damage of the selective permeability of the cell surface or the formation of peptides that influence catalytically the oxygenation of hemoglobin. (auth)

598 RATES OF DNA SYNTHESIS IN A RADIATION-SENSITIVE SACCHAROMYCES MUTANT AFTER UV OR X-RAY IRRADIATION. Jannsen, Sigrid; Laskowski, Wolfgang; Lochmann, Ernst-Randolf (Freie Univ., Berlin). Z. Naturforsch., 24b: 1310-15(Oct. 1969). (In German).

The incorporation of thymidine-2-^{14}C-monophosphate (TMP) after uv and x irradiation in two diploid Saccharomyces strains with different radiation sensitivities of colony-forming ability was

measured to determine the rate of DNA synthesis. The sensitive strain was homozygous for a gene causing uv and x-ray sensitivity (r_1^s r_1^s) whereas the resistant strain was homozygous for the corresponding wild type allels (++). The TMP-incorporation was measured for a period of 3 hr either immediately after irradiation or after an interval of 3 or 6 hrs in nutrient medium without radioactive TMP. The dose effect curves obtained were generally biphasic with a steep slope at low doses and with a shallow slope at high doses. The values obtained for the r_1^s r_1^s-strain were significantly lower than those of the ++-strain. The difference in the rate of DNA-synthesis increased with increasing interval between the time of irradiation and the time of application of TMP. (auth)

599 MICROCALORIMETRY OF THE PROCESSES OF COAGULATION IN NORMAL CONDITIONS AND AFTER EXPOSURE TO A CONSTANT MAGNETIC FIELD. Piruzyan, L. A.; Rozenfel'd, M. A.; Glezer, V. M.; Lomonosov, V. A. (Academy of Sciences, Moscow). Aerosp. Med., 40: 1140-1(Oct. 1969).

The action of a constant magnetic field leads to acceleration of the coagulatory process, accompanied by more intensive generation of heat. Thorough testing of this new, highly sensitive calorimetric method, capable of registering disturbances in the coagulatory system of the blood, will make possible its use as a new test in clinical and experimental applications. (auth)

600 A COMPARISON OF THE EFFECTS OF ULTRAVIOLET AND IONIZING RADIATIONS ON TRYPSIN ACTIVITY AND ON ITS CONSTITUENT AMINO ACIDS. Burke, Morris; Augenstein, Leroy (Michigan State Univ., East Lansing). Biochem. J., 114: 535-45(Sept. 1969).

It was found that photons of 254nm uv light, ^{60}Co γ rays and 1 MeV electrons produce different patterns of destruction of individual amino acids in dried films of trypsin and in the corresponding amino acid mixture. For example, in the amino-acid mixture uv light destroys tyrosine, tryptophan and cystine, whereas in trypsin only cystine is disrupted, but with 10 times the yield. Further, in the amino acid mixture loss of half-cystine is a simple exponential function of dose, but in trypsin there appear to be two exponential components of the loss with yields that differ by a factor of 35. Both the γ rays and electrons destroy half-cystine, tryptophan, histidine and methionine in the amino acid mixture with remarkably high yields, whereas in trypsin, doses that destroy almost all of the enzymic activity produce no detectable destruction of amino acid residues. These marked differences between the two preparations show that the radiosensitivity of a given amino acid alone and in a protein is different, and suggest that in trypsin there is fairly extensive migration of energy, charge or both, with localization of damage at specific sites determined by this enzyme's internal organization. All three types of radiation produce appreciable amounts of damaged (not completely inactivated) molecules which are prevented from reassuming an active configuration by the addition of 5.5 M-urea; thiol reagents have a similar effect after bombardment with uv light or electrons. The patterns of destruction produced by γ rays and by electrons in both the amino acid mixture and in trypsin are different (some of the yields vary by a factor of 30). This result appears to be inconsistent with the popular belief that most of the energy absorbed from γ rays is associated with very high energy electrons. (auth) (UK)

601 FREE AMINO ACIDS IN LIVER AND BLOOD PLASMA FOLLOWING LOCALIZED IRRADIATION OF THE LIVER. Staehler, Fritz; Kuenkel, Hans A. (Univ., Hamburg). Strahlentherapie, 138: 239-46(Aug. 1969). (In German).

After partial-body irradiation in the liver of rats with 1000 rad only negligible changes of the concentration of free amino acids were observed during the first 4 days post radiation in the cytoplasm of the liver as well as in the blood plasma of the animals. After 5000 rad, however, the intracellular concentration of most amino acids significantly increased within 24 to 48 hr. In the case of methionine, isoleucine, trypsine, and valine the concentration reached more than ten times the amount of the control. Simultaneously, the order of succession was changed in a typical correlation. (auth)

602 EFFECTS OF X RADIATION ON SEVERAL RAT ORGANS WITH RESPECT TO THEIR CONTENT OF OXIDIZED GLUTATHIONE. Rathgen, Guenther H. (Univ., Mainz). Strahlentherapie, 138: 232-8(Aug. 1969). (In German).

Thirty minutes after a whole-body irradiation with 800 R, a decrease of the reduced glutathione is observed in the blood of the rat, with an increase of the oxidized glutathione, in a non-equimolar extent. Two hr after irradiation, the reduced glutathione is normalized, but a new decrease is observed in the next 24 hr. A similar variation of the oxidized form does not occur. Thirty minutes after irradiation an increase of the concentration of reduced glutathione in the spleen, kidney, and to the highest extent in the liver is noticed. At the same time, the amount of GSSG decreases. One hundred and twenty minutes post radiation the GSH-concentration in spleen and kidney is below, 24 hr post radiation above the control values. Compared with the concentration 30 minutes after irradiation, the GSH-level in the liver is decreased 60 and 120 minutes post radiation, but—until 24 hr—always higher than the level found in untreated animals. The concentration of GSSG increases 2 hr after irradiation but a new decrease follows. (auth)

603 STUDIES OF THE NUCLEONIC DNA CONTENT OF NEUTROPHIL LEUKOCYTES IN GUINEA PIGS RECEIVING WHOLE-BODY RADIATION OF 600 R. zur Horst-Meyer, Horst; Ebert, W.; Stiller, K.-J. (Univ., Berlin. Friedrich-Schiller-Univ., Jena, Ger.). Strahlentherapie, 138: 229-31(Aug. 1969). (In German).

Microphotometric studies of bone marrow smears of guinea pigs after Feulgen coloration show a significant increase of the nuclear surface and of the DNA content of the polynuclear neutrophile granulocytes, within three days after a whole-body irradiation with 600 R. At the fifth day all values are almost normalized. The increase of nuclear surface is highly significant, but the increase of the DNA content is only significant to the P = 5% level. Taking in account the inherent error possibility of the method, it is not possible to confirm at this level of significance the hypothesis of Weicker concerning the increase of DNA. According to this hypothesis, the increase of the nuclear segmentation index in the neutrophile granulocyte after an irradiation is caused by an inhibition of mitotic diversion in the myelocyte stages. (auth)

604 GLUCOCORTICOID FUNCTION OF THE ADRENAL CORTEX IN RATS TREATED WITH ^{210}Po. Moroz, B. B.; Pinelis, V. G. (Inst. of Biophysics, Moscow). Radiobiologiya, 8: 689-92 (1968). (In Russian).

Treatment of rats with 0.08 mCi/kg doses of ^{210}Po (acute form) produced an increase in the corticosterone content of blood plasma and adrenal glands 24 hrs after administration of the isotope subcutaneously. During the period of acute injury (10th day), the corticosterone content in the blood plasma and adrenals was reduced by 50 and 30%, respectively. Similar phase changes were also detected in rats administered 0.02 mCi/kg doses, moreover, the inhibition of the adrenal function during the latent period was far more pronounced than after the larger doses. This was associated both with absorbed dose of ^{210}Po in the adrenals and duration of the pathological process. (JPRS) (TSS)

605 PHOSPHORYLATION OF THYMIDINE IN THE THYMUS AND SPLEEN OF RATS IN THE EARLY PERIODS AFTER WHOLE-BODY γ-IRRADIATION. Filippovich, I. V.; Romantsev, E. F. (Inst. of Biophysics, Moscow). Radiobiologiya, 8: 680-3(1968). (In Russian).

Whole-body γ irradiation of rats at a dose of 1000 R produces a sharp decrease in the thymidine kinase activity in the tissue of the thymus gland within 3 min after irradiation. During the subsequent periods the activity of the enzyme gradually approaches the control value. A decrease in the amount of thymidine phosphates is not associated with activation of the processes of catabolism of the thymidylic nucleotides and thymidine in the irradiated tissue. In the spleen at these same periods after irradiation, no such sharp drop in the degree of phosphorylation of thymidine is observed. The sharp decrease in the thymidine kinase activity in the thymus gland may be associated with radiation damage to the microstructures of the cell or individual macromolecules. At the same time, a definite role in the decrease in the thymidine kinase activity may be played by hormonal effects. (JPRS)

606 METABOLISM OF GLUCOSE-1-^{14}C IN THE IRRADIATED RAT ORGANISM. Kendysh, I. N. (Inst. of Biophysics, Moscow). Radiobiologiya, 8: 676-9(1968). (In Russian).

The rate of disappearance of ^{14}C-labeled glucose from the blood, the degree of its utilization by the liver and muscles, and the intensity of incorporation into liver glycogen and exhaled carbon dioxide, were studied in starving rats, x-irradiated at a dose of 750 R. It was found that irradiation does not influence the degree of utilization of glucose by the muscles, but during the first three days it intensifies its incorporation into the liver glycogen and its oxidation to carbon dioxide. It was concluded that after irradiation the glucose production is increased. (JPRS) (TSS)

607 EFFECTS OF X IRRADIATION ON THE GLYCOGEN METABOLISM IN THE CELLULAR AND INTERCELLULAR PORTIONS OF THE RABBIT BONE MARROW. Filippova, V. N.; Soldatenkova, L. I.; Seits, I. F. (Scientific Research Inst. of Hematology and Blood Transfusion, Leningrad). Radiobiologiya, 8: 749-52(1968). (In Russian).

The distribution of glycogen and the glycogen synthesizing enzymes, phosphoglucomutase, UDPG-pyrophosphorylase, and UDPG-glycogen transferase, in the cellular and noncellular portions of the rabbit bone marrow before and 24 hrs after irradiation of the animals by 1000 R of x rays, was studied. A decrease in the activity of the glycogen-synthesizing enzymes in the cellular portion of the bone marrow approximately proportional to the loss of cellular mass, as a result of irradiation, was shown. High radiosensitivity of the UDPG-glycogen transferase of the noncellular substance of the bone marrow was noted. An increase in the α-amylase activity in the cells and noncellular substance of the bone marrow and in the glycogen phosphorylase activity in the noncellular substance, with a substantial drop in its activity in the cells, were demonstrated after irradiation. (JPRS)

608 CHANGES IN SKIN LIPIDS FOLLOWING IRRADIATION WITH ULTRAVIOLET LIGHT. Simko, V.; Bobek, P.; Ginter, E. Vnitr. Lek., 15: 150-7(Feb. 1969). (In Czech).

Following an 84-day irradiation of rats with uv rays, a sharp rise in sterol substances was observed in their skin. Collection of sebaceous skin excretion from seven volunteers revealed that, following irradiation, excretion of sterols and esterified fatty acids in sebaceous matter does not rise, but exhibits a declining trend. Irradiation by uv rays thus does not increase the loss of sterols through the skin surface. Quantitative considerations indicate that the reduction of hepatic cholesterol, observed in rats irradiated as part of another experiment, is not connected with transformation of cholesterol into vitamin D. Reduction of hepatic cholesterol following uv irradiation probably is bound up with the controlling effect of uv light or vitamin D on cholesterol metabolism, probably with hepatic biosynthesis. (auth)

609 THE PHOTOCHEMISTRY OF 4-THIOURIDINE IN ESCHERICHIA COLI t-RNA$_1^{Val}$. Favre, A.; Yaniv, M.; Michelson, A. M. (Institut de Biologie Physico-Chimique, Paris). Biochem. Biophys. Res. Commun., 37: 266-71(Oct. 8, 1969).

A specific modification of t-RNA$_1^{Val}$ is described. Irradiation at 335 mμ of t-RNA in aqueous solution caused a local change in the conformation of the molecule, the result of a special quantitative modification of the 4-thiouridine. This photoreaction occurred only when the 4-thiouridine in the 8th position interacts strongly with a non-adjacent base: a cytosine residue in 13th position. (auth)

610 TRANSITORY FREE RADICALS IN IRRADIATED ANIMAL TISSUES. Kenny, P.; Commoner, B. (Washington Univ., St. Louis). Nature (London), 223: 1229-33(Sept. 20, 1969).

A study is described of transient free radicals produced in various animal tissues in association with biological radiation damage. The variation in the radiosensitivity of different organs is emphasized. (UK)

611 HAZARDS IN THE USE OF LIQUEFIED GAS REFRIGERANTS IN IRRADIATION EXPERIMENTS. McLaren, K. G. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Int. J. Appl. Radiat. Isotop., 20: 735-8(Oct. 1969).

Some special factors which need to be considered in radiation chemistry experiments in which samples kept at low temperatures by liquefied gas are exposed to high energy radiation, such as γ rays and electron beams are as follows: possibility of radioinduced rupture of brittle vessels containing samples or refrigerant, condensation of combustible hydrocarbons out of the air into refrigerant, and formation of ozone both from atmospheric oxygen and liquid oxygen. The potential hazards arising from these and associated phenomena are discussed, and precautions for low temperature irradiations are suggested. (UK)

612 DIASTEREOISOMERS OF URACIL GLYCOSIDE PHOTOHYDRATES. Pietrzykowska, Irena; Shugar, D. (Inst. of Biochemistry and Biophysics, Warsaw, Univ. of Warsaw). Biochem. Biophys. Res. Commun., 37: 225-32(Oct. 8, 1969).

The two diastereoisomers of various uracil glycoside photohydrates were separated by thin-layer chromatography, and one of the isomeric photohydrates of deoxyuridine isolated in crystalline form. The ratios of the two isomers formed were independent of the wavelength of irradiation. The dark dehydration of each of the isomers follows a different pathway, both in acid and alkaline media, the nature of which is described. (auth)

613 STUDIES ON PHYTOHEMAGGLUTININS. II. PHYTOHEMAGGLUTININS OF PISUM SATIVUM L. AND LENS ESCULENTA MOENCH: SPECIFIC INTERACTIONS WITH CARBOHYDRATES. Entlicher, G.; Ticha, M.; Kostir, J. V.; Kocourek, J. (Charles Univ., Prague). Experientia, 25: 17-19(Jan. 15, 1969).

The contents of fatty acid CoA derivatives were measured in mouse liver after whole-body x irradiation with 690 R. While the contents were almost unchanged in fed mice, a decrease occurred in starved mice 24 hr after irradiation. The results are discussed with respect to fatty acid synthesis. (auth)

614 EFFECT OF PULSED MICROWAVES AT X-BAND ON SKIN METABOLISM. Jawrence, J. C. (Birmingham Accident Hospital, Eng.). Non-Ioniz. Radiat., 1: 80-4(Sept. 1969).

Apparatus used to expose skin to a frequency of 9.6 GHz with a pulse duration of 0.25 μs and a repetition frequency of 4 kHz is described. This gave a ratio of 1000 : 1 of peak to mean power. With this apparatus it was found that an exposure of 6,000 mJ/cm^2 reduced respiratory activity of skin by 50%. Other experiments were made to determine the effect of pulsed microwave energy on certain specific aspects of skin biochemistry, especially biosynthesis of intercellular materials and specific cell components. The histology of skin after exposure to microwaves was also investigated. The findings of these experiments are compared with those obtained previously using a continuous source of radiation. (auth) (UK)

615 FUNDAMENTAL PHYSICAL CONCEPTS UNDERLYING ABSORPTION OF MICROWAVE ENERGY BY BIOLOGICAL MATERIAL. Grant, Edward H. (Queen Elizabeth Coll., London). Non-Ioniz. Radiat., 1: 77-9(Sept. 1969).

The degree of biological damage sustained when a living organism is exposed to microwave radiation is related to the amount of energy absorbed which, in turn, depends upon the complex permittivity of the constituents. The variation of permittivity and conductivity with frequency is discussed, and some examples are given for pure water. The relevance of the above concepts to microwave radiation absorption is explained. (auth) (UK)

Immunology

Refer also to abstracts 820, 831, 879, and 906.

616 IMMUNOSUPPRESSION DURING THE TREATMENT OF SOLID TUMORS AND ACUTE LEUKEMIA IN CHILDHOOD. Neidhardt, M. (Univ., Mainz). Ger. Med. Mon., 14: 86-9 (Feb. 1969).

Use of ionizing radiation and other cytostatic agents in the treatment of tumors and leukemia has the undesirable side-effect of causing immunosuppression. The actual degree of immunosuppression produced by radiotherapy and other current therapeutic schemes for acute leukemia and solid tumors in childhood was evaluated in studies on guinea pigs, rabbits, and humans. The technique employed was the photometric estimation of hemagglutination-inhibiting antibodies against influenza virus. Rabbits were given partial-body radiation (8 × 10 cm fields over abdomen and back) with a total of 4000 R given in single doses of 200 R on 5 days a week for 4 weeks. Another group received the same radiation dose on 3 days a week for 6½ weeks. On 3 other days in each week the animals in this group were each given cyclophosphamide 5 mg/Kg parenterally. Only in a group given high-dose cyclophosphamide therapy alone was there any significant reduction in antibody titer compared with controls. In clinical studies, 6 children with tumors were treated with cytostatic agents alone (cyclophosphamide 5 mg/Kg daily), by radiation alone (3000 R to the entire central nervous system), or with cyclophosphamide and radiation in combination. Seven children with acute blast-cell leukemia were treated with prednisolone (3 mg/Kg daily) plus 6-mercaptopurine (2.5 mg/Kg daily), or with prednisolone (same dosage) plus amethopterin (2.5 mg/Kg daily parenterally for 14 days). In the children with solid tumors the rise in antibody titer was delayed and the final titer was only half that of the controls. In the children with leukemia the average rise in antibody titer was small. However, the range of variation within the individual groups was wide. (BBB)

617 GERM-FREE BIOLOGY. EXPERIMENTAL AND CLINICAL ASPECTS. Proceedings of an International Symposium on Gnotobiology Held in Buffalo, New York, June 9–11, 1968. Mirand, Edwin A.; Back, Nathan (eds.). Advances in Experimental Medicine and Biology. Volume 3. New York, Plenum Press, 1969. 433p. $22.50. (CONF-680659).

Separate abstracts were prepared for six papers presented at this conference. An additional forty papers were presented on various aspects of germfree biology. (H.L.W.)

For abstracts of individual papers see: 618–621, 842, and 843.

618 DIFFERENTIATION OF POTENTIALLY IMMUNOCOMPETENT CELLS IN THE MOUSE. Cudkowicz, G.; Shearer, G. M. (Roswell Park Memorial Inst., Buffalo). pp 227-35 of Germ-Free Biology. Experimental and Clinical Aspects.

Mirand, Edwin A.; Black, Nathan (eds.). New York, Plenum Press, 1969.

From Symposium on Gnotobiology, Buffalo, N. Y. See CONF-680659.

The lymphopoietic pathway of differentiation produces an extremely specialized and heterogeneous population of functional immunocytes. The specialization conferred upon these end cells results in antibody production against a single antigenic determinant, or specificity differentiation in production of a single class of antibody molecule among several directed against the same antigen, or class differentiation; in production of one allotypic variant of a given molecular species of antibody, or allotypic restriction. Experiments with anti-sheep immune reactions indicate that the immediate precursors of antibody-forming cells are also heterogeneous and that they display in the spleens of adult mice and in bone marrow-thymus cell mixtures the same type of differentiation detectable among their progeny cells. In other words, ASU reactive with the antigen complex of SRBC, are tooled up prior to antigen administration to generate either direct or indirect PFC (class differentiation), or CFC without PFC and vice-versa (specificity differentiation or class differentiation). Due to the existence of natural anti-SRBC antibodies in mice, it was conceivable that differentiation of ASU was due to cross-reacting antigens of the intestinal flora. Experiments with germfree mice have not supported this idea. If cells of the immune system of mice descend from undifferentiated (pluripotent) hemopoietic stem cells, it must be concluded that diversity-generating processes have taken place before the formation of ASU. Similar processes are responsible for differentiation along other pathways, e.g., erythropoietic and granulocytopoietic. Possibly the same general control mechanisms operate in differentiation of all hemopoietic cell lines. We would then expect to find potentially immunocompetent cells with intermediate properties of differentiation and maturation, particularly in adult or fetal marrow and thymus. Since marrow and thymus contain cells endowed with different functions, differentiation may occur independently in each cell line, i.e., in each component of ASU. One can visualize the interplay or random association of such heterogeneous and specialized cells (upon antigenic stimulation) as a source of sufficient variability to account for the great heterogeneity of antibody responses and for the spectrum of immune reactivities of mammals. Recently introduced techniques of cellular immunology, antibody responses in vitro, and dissociation of ASU in monofunctional cells render these concepts amenable to experimental test. (auth)

619 DEVELOPMENT OF IMMUNOLOGIC COMPETENCE IN GERMFREE AND CONVENTIONAL MICE. Bosma, M. J. (Inst. for Cancer Research, Philadelphia). pp 249-58 of Germ-Free Biology. Experimental and Clinical Aspects. Mirand, Edwin A.; Back, Nathan (eds.). New York, Plenum Press, 1969.

From Symposium on Gnotobiology, Buffalo, N. Y. See CONF-680659.

These studies demonstrated that the postnatal increase of immunologic competence to sheep RBC antigen was identical in germ free (GF) and conventional (CVN) mice. This finding was based on an unbiased experimental test system that allowed us to relate hemagglutinin synthesis to a cellular definition of immunologic competence. Thus, the very low levels of serum γ-globulin and the relative lack of any morphological signs of immune responsiveness in GF animals do not imply an underdeveloped immune capacity, but rather the absence of immunologic expression normally due to antigenic stimuli or subliminal infection. Immune competence, on the other hand, is not dependent on extra-uterine exposure to the normal bacterial load. Also the very low level of γ-globulin in GF mice and consequently the relative lack of maternal antibodies are apparently of no consequence to the development of immunologic competence. In the cell transfer system, one can relate hemagglutinin synthesis (expression) to immunologic competence with reasonable accuracy. However, the expression of immune competence of intact individuals is subject to homeostatic regulatory factors to a greater degree than in a cell transfer system and it is possible that these factors are influenced by changes in the environment. The effects of this regulation may be apparent in degree, depending on differences in type and dose of antigen and of its route of injection, time, and manner of antibody assay. Finally, the logarithmic increase of lymphoid precursor cells sensitive to sheep RBC antigen was independent of the bulk of naturally occurring antigen, and also was apparently not affected by the normal level of γ-globulins or by maternal antibodies. It would seem, therefore, that the ontogeny of immunologic precursor cells is an intrinsic property of the organism whereby: precursor cells are programmed to elaborate an immunologic specificity by some mechanism independent of antigenic input, or, alternatively, antigen-processing cells that are not step-limiting cellular events, program precursor cells with immunologic specificity. (auth)

620 HEMOLYTIC PLAQUE-FORMING CELLS IN ANTIGEN-SENSITIVE UNITS IN SPLEENS OF GERMFREE AND CONVENTIONAL MICE. Shearer, G. M.; Cudkowicz, G.; Walburg, H. E. Jr. (Roswell Park Memorial Inst., Buffalo. Oak Ridge National Lab., Tenn.). pp 269-75 of Germ-Free Biology. Experimental and Clinical Aspects. Mirand, Edwin A.; Back, Nathan (eds.). New York, Plenum Press, 1969.

From Symposium on Gnotobiology, Buffalo, N. Y. See CONF-680659.

The direct plaque response of intact germfree mice to SRBC antigens is equivalent to the response of conventional mice in terms of numbers of PFC and kinetics of PFC formation. After radiation injury (550 R), the number of surviving ASU, the regenerative potential of the immune system, and the kinetics of PFC formation do not differ in germfree and conventional mice. This implies that the unirradiated mice were alike also with respect to the total number of ASU and of more primitive lymphopoietic progenitor cells. Hence, the differentiation of ASU from more primitive elements, presumably contained in marrow and thymus, and the differentiation of PFC from antigen-sensitive units, were not detectably affected by bacterial antigen load. The germfree mice could have been exposed to relatively small amounts of bacterial antigens (cross-reacting with SRBC) contained in the sterilized food. It is unlikely, however, that these amounts of antigens were sufficient to induce immunocompetent cell differentiation quantitatively undistinguishable from that which occurred in conventional mice, since the magnitude of an immune response is a function of small amounts of antigen administered rather than a threshold antigen-dose effect. Furthermore, some enteric bacteria such as Escherichia coli and Aerobacter aerogenes are capable of inducing the appearance of anti-sheep PFC in the spleens of specific pathogen-free mice upon intraperitoneal injection. For these considerations, it is likely that cellular differentiation of the immune system of mice is not only independent of antigen load, but of cross-reacting antigens altogether. (auth)

621 SEVERITY OF THE PARENT TO F_1 GRAFT-VERSUS-HOST REACTION IN IRRADIATED GERMFREE MICE. Walburg, H. E. Jr.; Cosgrove, G. E. (Oak Ridge National Lab., Tenn.). pp 277-86 of Germ-Free Biology. Experimental and Clinical Aspects. Mirand, Edwin A.; Back, Nathan (eds.). New York, Plenum Press, 1969.

From Symposium on Gnotobiology, Buffalo, N. Y. See CONF-680659.

Results demonstrate that a severe GVH reaction can occur in mice reared in a germfree environment. Studies with lethal combinations of x radiation and parental spleen cells did not clearly establish an influence of microbial environment on the mortality associated with the foreign spleen reaction, since experiments using the RFC3 cross demonstrated decreased mortality in the conventional system whereas those using the reciprocal cross showed an increased mortality when conventional and germfree systems were compared. On the other hand, there was no demonstrable influence of the microbial flora on the development of lymph node granulomas in these mice, suggesting that mortality and such parameters as mean survival time may not always reflect the true severity of the GVH reaction. Further study of the foreign spleen reaction in germfree mice employed sublethal combinations of x-ray exposure and spleen cell dose, that produce less severe and less rapidly developing lymph node granulomas, a system that might be more sensitive to effects of the microbial flora than those used previously. With this technique, lymph node granulomas caused by the foreign spleen reaction proved as severe in germfree mice as in their conventional counterparts. These data suggest that the microbial flora that is absent in germfree mice plays no role in the development of GVH reaction in sublethally irradiated F_1 hybrid mice injected with parent spleen cells. The ability of spleen cells from conventional and germfree donors to produce similar GVH pathology suggests that they are equally immunocompetent when stimulated by foreign tissue antigens. This is consistent with earlier studies that demonstrated no difference in immunocompetence of spleen cells from germfree and conventional mice challenged with sheep erythrocytes. (auth)

622 RADIOISOTOPE IN THE STUDY OF ANTIGEN–ANTIBODY REACTION. Irie, Minoru; Tsushima, Toshio (Tokyo Univ.). Tasha, 6: 273-7(Apr. 1969). (In Japanese).

A method is described for the measurement of protein hormones using radioisotopes and the antigen-antibody reaction. Specific anti-hormone antibody was used for measurement of isotope-labeled hormone mixed with the sample containing unlabeled hor-

mone. Various procedures were used to separate antibody-bound hormone from free hormone. Radioimmunoassays based on these principles were applied to measurement of various proteins such as thyroglobulin and enzymes. (M.M.B.)

623 SECOND INTERNATIONAL CONGRESS OF THE TRANSPLANTATION SOCIETY, NEW YORK, N. Y., SEPT. 7-11, 1968. Transplant. Proc., 1: No. 1, Pts. 1 and 2, 1-682 (Mar. 1969). (CONF-680922).

A series of symposia are presented on bone marrow transplantation; pregnancy and transplantation; cancer, immunology, and transplantation; organ preservation; kidney transplantation; and special topics in organ transplantation. Topics discussed at several scientific forums included organ transplantation, transplantation genetics, histocompatibility testing, heterologous antisera, transplantation antigens, α-globulins and other serum components in transplantation, and immunobiology. The use of ionizing radiation as an immunosuppressive agent in preventing graft rejection is described in several articles of this series. Eighteen separate abstracts were prepared for inclusion in NSA. (BBB)

For abstracts of individual papers see: 624–641.

624 BONE MARROW TRANSPLANTATION IN MAN. Mathe, G.; Amiel, J. L.; Schwarzenberg, L.; Schneider, M.; Cattan, A.; Schlumberger, J. R.; Nouza, K.; Hrask, Y. (Hopital Paul-Brousse, Villejuif, France). Transplant. Proc., 1: No. 1, Pt. 1, 16-24 (Mar. 1969).

From 2nd International Congress of the Transplantation Society, New York. See CONF-680922.

Bone marrow transplantation in humans is reviewed with reference to its use in accidentally irradiated subjects and in leukemia patients submitted to supralethal doses of whole-body irradiation. The effect of the relation of the host to the donor on the success of allogeneic marrow transfusions is shown. The recipients were patients with acute leukemia who were given a lethal dose of irradiation prior to the marrow transfusion. Takes of the graft were much more frequent when the recipient and donor were related. Little correlation was found between successful take of bone marrow grafts and blood transfusions given prior to irradiation. The secondary syndrome is very severe in man, as it is in monkeys, and its onset is generally very early, when the marrow aplasia from whole-body irradiation at the high dose (800 rad) required is still present. Possible future lines of research would be: to attempt to replace LD_{100} irradiation by another method of preconditioning the recipient, or sub-lethal irradiation complemented by administration of antilymphocytic antisera might be used. (BBB)

625 EXPERIMENTAL ASPECTS OF BONE MARROW TRANSPLANTATION IN PRIMATES. van Bekkum, D. W.; Balner, H.; Dicke, K. A.; van Putten, L. M. (Radiobiological Inst. TNO, Rijswijk, Netherlands). Transplant. Proc., 1: No. 1, Pt. 1, 25-30 (Mar. 1969).

From 2nd International Congress of the Transplantation Society, New York. See CONF-680922.

Results of bone marrow transplantation in monkeys are compared with those in rodents and in man. In mice and rats the first clinical symptoms of secondary disease do not develop before the 3rd week after transplantation and, even with the least compatible strain combinations, some of the chimeras survive. In monkeys and man the secondary syndrome may start as early as 6 days after transplantation, if no additional therapy besides bone marrow is given. The average survival time in a series of 25 monkeys grafted with 4×10^8 allogeneic bone marrow cells/kg body weight was 13.5 days and the longest survival time was 25 days. Another difference between mice and monkeys is the number of auto- (or iso-) geneic cells required to protect the lethally irradiated recipient (mouse 5×10^6/Kg, monkey 4×10^7/Kg; for humans the best estimate is 1×10^8/Kg). In contrast to the experience in humans and dogs, no serious difficulties were encountered in obtaining bone marrow takes in monkeys. When the recipient was irradiated with a whole-body dose of at least 760 rad and 4×10^8 allogeneic bone marrow cells were infused, takes occurred in more than 95%. Pre-immunization of recipient and use of frozen cells are discussed. Acute secondary disease in monkeys can be mitigated by treating the recipients after bone marrow transplantation with immunosuppressive agents such as cyclophosphamide and amethopterin. Prevention of acute secondary disease is also pursued by the selection of compatible bone marrow donors by means of leucocyte antigen typing. Another possibility of changing the acute form of secondary disease into a more benign syndrome is the grafting of fetal liver cells instead of bone marrow. However, results of this approach in monkeys were not fruitful. (BBB)

626 SYMPOSIUM ON BONE MARROW TRANSPLANTATION: EXPERIMENTAL ASPECTS IN CANINES. Thomas, E. Donnall; Storb, Rainer; Epstein, Robert B.; Rudolph, Robert H. (Univ. of Washington, Seattle). Transplant. Proc., 1: No. 1, Pt. 1, 31-3 (Mar. 1969).

From 2nd International Congress of the Transplantation Society, New York. See CONF-680922.

Dogs could be protected after as much as 1800 R of whole-body irradiation by administration of their own marrow obtained before irradiation. However, use of randomly selected, unrelated donor and recipient for marrow grafting after 1200 to 1500 R did not result in long-term radiation chimeras unless means were taken to prevent infections. Dogs with allogeneic marrow grafts that lived beyond 120 days regained their health and showed no late irradiation effects except for greying of hair. Two male dogs that were given 1500 R followed by marrow from unrelated female donors were found to have female type cells as seen by cytogenetic analysis 4 yr later. The use of allogeneic marrow infusion following near lethal radiation exposure was studied in dogs given 600 R. One dog did not receive marrow while the other was given more than 10×10^9 allogeneic marrow cells. Results showed no significant difference in hematologic parameters or in survival between the two. Thus, marrow is neither harmful nor helpful at this level of radiation exposure. (BBB)

627 EFFECT OF SYNGENEIC ANTILYMPHOCYTE SERUM ON RAT-MOUSE RADIATION CHIMERAS: A PRELIMINARY REPORT. Gengozian, N.; Congdon, C. C. (Oak Ridge Associated Universities, Tenn.). Transplant. Proc., 1: No. 1, Pt. 1, 34-8 (Mar. 1969).

From 2nd International Congress of the Transplantation Society, New York. See CONF-680922.

In radiation chimeras of the xenogeneic rat-mouse type, sporadic, spontaneous reversion to host hemopoietic systems is sometimes observed. The cause and mechanism of such reversions are not known. A reseeding of host hemopoietic elements was demonstrated in rat-mouse radiation chimeras after injection of mouse spleen and lymph-node cells. Male and female mice of the $C3BF_1$ strain, 12 to 16 weeks old, were given whole-body x irradiation of 950 R or 1100 R and then injected intravenously with 100×10^6 rat bone-marrow cells. The rat-mouse radiation chimeras resulting from this treatment were used 90 to 200 days later. The radiation rat-mouse chimeras were injected with mouse lymphoid cells or mouse antilymphocyte serum (ALA). The chimeras showed a marked response to these treatments as evidenced by loss in body weight, gross appearance, and hematologic effects. None of the chimeras treated with ALS showed any evidence of replacement of rat hemopoietic tissue by mouse elements. The major pathologic processes seen at autopsy in the chimeras given ALS were bone marrow necrosis and depletion of lymphatic tissues. (BBB)

628 IMMUNOLOGICAL CONSIDERATIONS OF BONE MARROW TRANSPLANTATION. Uphoff, Delta E. (National Cancer Inst., Bethesda, Md.). Transplant. Proc., 1: No. 1, Pt. 1, 39-43 (Mar. 1969).

From 2nd International Congress of the Transplantation Society, New York. See CONF-680922.

Stem cell modifications were induced by simple laboratory procedures that might be used in any routine attempt to transplant bone marrow into a lethally irradiated recipient, and included use of mixtures of marrows of several genotypes, inoculation of marrow from donors in which neonatal tolerance had been induced, and in vitro preincubation of marrow with washed allogeneic erythrocytes. The common factor was the exposure of the stem cells to antigen prior to transplantation. It was found that even brief in vitro contact between allogeneic marrows decreases the protective capacity of the pooled cells. Mixed chimeras occurred when neither the irradiated recipient nor the two donor strains of the marrow pool were related. Allogeneic marrow was also modified by in vitro contact for 35 min at 26°C with erythrocytes of recipient strain or reciprocal hybrid origin, as reflected in increased late mortality. Lethally irradiated AKR mouse recipients inoculated with normal CBA marrow had an incidence of thymic lymphomas of 65%. The ease with which the stem cells were modified suggested that there was a survival advantage that utilized this mechanism. From the viewpoint of marrow transplantation, however, this mechanism was a decided disadvantage. In compatible allogeneic strains in which the donors were presensitized against recipient antigen, good protection was followed by a severe secondary disease syndrome during the fourth week post-irradiation. (BBB)

629 AN ANALYSIS OF THE INCIDENCE OF EARLY TRANSPLANT FAILURE DATA FROM THE HUMAN KIDNEY TRANSPLANT REGISTRY. Murray, James E. (Peter Bent Brigham Hospital, Boston). Transplant. Proc., 1: No. 1, Pt. 1, 197-205 (Mar. 1969).

From 2nd International Congress of the Transplantation Society, New York. See CONF-680922.

An analysis of duration of survival or function of transplants was evaluated for kidney transplant subjects. The early post-operative course of transplants receiving local x-ray therapy to suppress the initial immunological response was assessed. Application of this method of analysis to the postoperative course of transplants receiving local x-ray therapy to suppress the initial immunological response was made. A significant difference between the irradiated and nonirradiated transplant from cadavers appeared already on the first day post-transplantation, implying the operation of factors other than irradiation, such as differences in cadaver organ procurement and preservation and donor selection. Examination of early transplant failure incidence substantiated recent improvement in results with transplants from siblings and parents. The analysis is consistent with two subpopulations of transplants reflecting immediate and delayed causes of nonfunction. A logarithmic transformation permitted statistical testing of results of function within 120 days post-transplant, and a statistical parameter, -b, was shown to be proportional to the rate of nonfunction characteristic of transplants from different donor groups. (BBB)

630 STUDIES ON THE MECHANISM OF CANINE RENAL ALLOGRAFT REJECTION. Foker, J. E.; Clark, D. S.; Pickering, R. J.; Good, R. A.; Varco, R. L. (Univ. of Minnesota, Minneapolis). Transplant. Proc., 1: No. 1, Pt. 1, 296-300 (Mar. 1969).

From 2nd International Congress of the Transplantation Society, New York. See CONF-680922.

A dog kidney allograft model, designed to allow isolation of the components of the rejection reaction, was used to gain evidence for the utilization and functional significance of complement (C′) in allograft rejection. In specific sensitization experiments a kidney was transplanted from the first dog, Dog A, to the recipient Dog B. After 4 days the graft was biopsied and removed, and the dog then was exposed to 600 R whole-body x radiation. When Dog B's peripheral white blood count fell below 500 cell/mm^3 (3–7 days) the second kidney from Dog A was implanted into Dog B. This kidney remained in Dog B for 4 hr then was returned to Dog A. Additional experiments were performed in which the first kidney from Dog A was left in Dog B for only 24 hr. At this time the kidney was removed and Dog B given 600 R of x radiation. In all 12 specific sensitization experiments the kidneys were rapidly infiltrated by leukocytes and most (8/12) went on to tubular degeneration and cessation of urine output within 12 hr. These results indicate that once sensitization has taken place, humoral elements are produced that are sufficient to initiate rejection. After exposure to these factors and return to the original dog, the graft is disrupted by autologous cells. In this dog renal allograft model, C′ consumption occurs in rejecting kidneys. In 9/11 kidneys exposed to a specifically sensitized leucopenic dog and returned to the donor a 25% or greater loss of C′ activity across the kidney was found. Evidence for C′ activation was not obtained while the kidney was in the sensitized irradiated dog. It is concluded that lymphocytes can invade an allograft in response to early antibody (19S) localized there. Lymphocytes have been shown to aggregate to antigen-19S antibody-C′ complexes. In addition, 19S antibodies can interact with lymphocytes and stimulate antibody production. Lymphocytes may not infiltrate an allograft until the appropriate recognition molecules are synthesized. These antibodies will then recruit additional lymphocytes to the graft to be sensitized. (BBB)

631 ANTIBODY PLAQUE REDUCTION IN VITRO AND IN VIVO: A RAPID ASSAY FOR IMMUNOSUPPRESSIVE AGENTS. Gavin, John; Waterbury, Walter; Freidman, Herman (Albert Einstein Medical Center, Philadelphia). Transplant. Proc., 1: No. 1, Pt. 2, 413-15 (Mar. 1969).

From 2nd International Congress of the Transplantation Society, New York. See CONF-680922.

Techniques utilizing antibody plaque-forming cells (PFC) were used to assay x radiation and other immunosuppressive agents. For in vivo experiments, mice were treated with the test agent and challenged with sheep red cells. The number of PFCs was determined in individual spleens 4 days later. The effects of Amethopterin, cyclophosphamide (Cytoxan), 5-fluorouracil (5-FU), 6-mercaptopurine (6-MP), vinblastine A, and cortisone acetate were tested in this manner. All of these drugs resulted in maximum immunosuppression of both serum antibody and individual PFCs when administered at the same time or 24 to 48 hr before immunization. Treatment of mice with whole-body x-irradiation resulted in greatest immunosuppression. Mice receiving 400 R or more one day before immunization had a 99% decrease in the number of expected PFCs 4 days after immunization. The secondary immune response, especially 7S PFC formation, appeared to be more resistant to suppression. For example, 200 to 400 R administered to mice primed 4 weeks before with antigen had little or no effect on the secondary PFC response. However, 600 or 800 R resulted in an 80 to 90% suppression. Mice treated with 900 R had little or no PFC response, either 7S or 19S, when injected for a second time with antigen. PFC formation in vitro was also highly resistant to x irradiation; 5000 or more R was needed for a 50% suppression. (BBB)

632 INDUCTION OF TOLERANCE WITH ANTILYMPHOCYTIC SERUM. Lance, E. M.; Medawar, P. B. (National Inst. for Medical Research, London). Transplant. Proc., 1: No. 1, Pt. 2, 429-32 (Mar. 1969).

From 2nd International Congress of the Transplantation Society, New York. See CONF-680922.

Some variables that affect the induction of transplantation tolerance in adult mice, using antilymphocytic serum (ALS) as an immunosuppressive agent, were investigated. The chimeric state was induced by use of ^{60}Co γ radiation or x radiation. In one experiment, two groups of adult male CBA mice were grafted with A-strain tail skin and were given injections of rabbit anti-mouse ALS on the 2nd, 4th, 6th, and 8th days after grafting. One group received no further injection, but in the second group ALS injections at the rate of 0.5 ml per week were continued until day 104. The mean survival times of the grafts after the last injection of ALS were 39.4 and 47.6 days respectively. Prolonging the course of ALS injections from 1 week to more than 3 months had therefore little or no effect on the after-life of the grafts when ALS injections ceased. Unless ALS is injected continuously, some means must be used to prolong its immunosuppressive action. Tolerance was tested as a possible means. It was shown that although ALS can abet the induction of specific immune tolerance by lymphoid cells of donor specificity, the state of tolerance is of moderate duration (100 to 200 days). Although individual grafts may survive upwards of 300 days, the rule is for chimerism to fade and for competence slowly to return, so that repetitions of the tolerance conferring dose of lymphoid cells may eventually sensitize their hosts instead of prolonging the tolerant state. These results are discussed in terms of lymphoid population dynamics. A mouse after chronic treatment with ALS is not, like an irradiated mouse, largely depopulated of lymphoid cells, so that the cells intended to confer tolerance do not proliferate explosively after their injection. This was confirmed by the potentiation of tolerance by doses of irradiation (450 R) that are known to be almost ineffective in themselves. (BBB)

633 IMMUNOSUPPRESSION BY ANTIBODY. Ryder, R. J. W.; Kilham, L. K.; Schwartz, R. S. (New England Medical Center Hospitals, Boston). Transplant. Proc., 1: No. 1, Pt. 2, 524-6 (Mar. 1969).

From 2nd International Congress of the Transplantation Society, New York. See CONF-680922.

The mechanism of immunosuppression by antibody was studied by examining the immune response of BDF_1 (C57BL/6 × DBA/2) mice to an intraperitoneal injection of sheep erythrocytes (SRBC). Mice, passively immunized at birth with anti-SRBC serum, were given 850-R total-body irradiation when aged 6 weeks, repopulated with spleen cells from normal mice, and then received the standard antigenic challenge. The immune response of the transferred normal cells was depressed, indicating the persistence of immunosuppressive antibody in their recipients. It was proposed that the unstimulated antibody-forming cell makes small quantities of antibody with a very low binding affinity. It is not stimulated by unprocessed antigen, but requires the oligonucleotide-immunogen complex elaborated by macrophages for its excitation. In contrast, the primed cells and their descendents secrete antibody with a higher binding affinity and can respond directly to unprocessed antigen. Thus, excitation of the primed immune system is not dependent on the antibody-sensitive phase in the macrophage and can take place in the presence of circulating antibody; whereas, by its action in the macrophage, immunosuppressive antibody can profoundly depress a primary immune response. (BBB)

634 PROTECTIVE ACTION OF HOMOLOGOUS SERUM COMPONENT ON GRAFT REJECTION. Hasek, M.; Karakoz, I.; Skamene, E.; Chutna, Jitka; Nouza, K.; Bubenik, J.; Nemec, M.; Sovova, Vlasta (Inst. of Experimental Biology and Genetics, Prague). Transplant. Proc., 1: No. 1, Pt. 2, 527-9 (Mar. 1969).

From 2nd International Congress of the Transplantation Society, New York. See CONF-680922.

Homologous hyperimmune duck serum can cause rejection of a tolerated skin graft or its protection. Tolerance was induced immediately after birth by injection of donor blood and by skin grafting. γ-Globulin and its 7S (IgG) fraction are the effective component of hyperimmune serum. The injection of purified γ-globulin, or of IgG fraction, is more effective than the corresponding amount of nonfractionated serum. IgM (19S) fraction is not effective in graft destruction. Effective antibody can be absorbed from immune globulin by isologous spleen cells at 0°C. After this absorption γ-globulin loses its activity and the spleen cells with passively bound antibody, irradiated with 12,000 R, are after intraperitoneal injec-

tion capable of transferring the reaction identical in its intensity and kinetics with the reaction following injection of immune globulin. In animals irradiated with a sublethal dose of x rays (400 R) all grafts survived after a mild Arthus-like reaction; microscopically they were characterized by a moderate dilatation of the vessels. Lymphocytic depletion caused by injection of heterologous duck antilymphocyte serum resulted in an effect that is analogous to that of irradiation. (BBB)

635 CELL TO CELL INTERACTION IN THE IMMUNE RESPONSE. Miller, J. F. A. P.; Mitchell, G. F. (Walter and Eliza Hall Inst. of Medical Research, Melbourne). Transplant. Proc., 1: No. 1, Pt. 2, 535-8 (Mar. 1969).

From 2nd International Congress of the Transplantation Society, New York. See CONF-680922.

The defective response of neonatally thymectomized mice to sheep erythrocytes (SRBC) can be reversed as effectively by thymus cells as by thoracic duct lymphocytes (TDL). The identity of the 19S hemolysin-forming cells (PFC) arising in the spleens of allogenically reconstituted mice was determined by means of anti-H2 sera. The results indicated that most, if not all, of the PFC produced were derived not from the inoculated lymphoid cells, but from some cell type already present in the thymectomized host. Irradiated recipients of lymphoid cells from various sources were used to identify the precursors of the PFC. The immune response to SRBC was determined 7 days postirradiation by assaying for both hemolytic foci and PFC. The results indicated that bone marrow (BM) lacks cells capable of initiating focus formation and that BM either promotes differentiation and proliferation of PFC precursors present in thoracic duct lymph or that it, itself, provides such precursors. In neonatally thymectomized hosts, TDL from mice tolerant of SRBC were as effective as control TDL in elevating the PFC response to horse RBC. The response of recipients of tolerant cells could be increased further by challenging simultaneously with both horse RBC and SRBC, but it was still significantly less than that of recipients of control TDL. (BBB)

636 STIMULATION OF LYMPHOCYTES BY DIRECT EXPOSURE TO ANTIGEN IN VITRO. Boak, J. L.; Mitchison, N. A. (St. Mary's Hospital, London). Transplant. Proc., 1: No. 1, Pt. 2, 539-42 (Mar. 1969).

From 2nd International Congress of the Transplantation Society, New York. See CONF-680922.

The secondary response to a hapten-protein conjugate 4-hydroxy-3-iodo-5-nitrophenyl acetic acid (NIP) ovalbumin was studied with thoracic duct lymphocytes. The aim was to test the ability of this relatively uniform population of cells to react with antigen in vitro, and to compare this with the reaction of cell aliquots exposed to the same antigen in vivo after adoptive transfer. The recipient mice received 600 R x irradiation shortly before cell transfer. Cell suspensions for irradiation were exposed under the same conditions as the animals, and were then mixed with nonirradiated cells for in vitro incubation. Control experiments showed that the irradiated cells were not themselves capable of giving rise to detectable levels of antibody after transfer. Comparison with spleen cell suspensions prepared from donors receiving equivalent immunization indicated that thoracic duct lymphocytes are two to three times more active in transferring antibody production. Stimulation applied in vitro regularly proved less efficient than when applied in vivo. The results showed that exposure of an isolated population of lymphocytes to a protein antigen can initiate a secondary response, and presumably therefore that other cells are not required for stimulation. The fact that stimulation in vitro was regularly less efficient than in vivo suggests that cell-cell interactions may nevertheless occur within intact lymphoid organs. (BBB)

637 ALLOGENEIC INHIBITION IN TOLERANT ANIMALS. Moeller, Erna; Lapp, Wayne; Lindholm, Leif (Karolinska Institutet, Stockholm). Transplant. Proc., 1: No. 1, Pt. 2, 543-7 (Mar. 1969).

From 2nd International Congress of the Transplantation Society, New York. See CONF-680922.

The mechanism of allogeneic inhibition in vivo and in vitro was studied with emphasis on the role of the immunological competence of the host and its lymphoid cells for the expression of the phenomenon. Thymectomy was performed on mice at the age of 4 to 5 weeks. Ten days later they were given 600-R whole-body x irradiation and immediately thereafter repopulated with syngeneic bone marrow cells. The results demonstrated that there was no difference in the growth of the A lymphoma in normal A mice or in A mice treated with thymectomy, irradiation, and reconstitution with bone marrow cells. However, a clear difference was observed between the growth of the lymphoma in the F_1 hybrid and the parental recipients. Fewer tumor cells were encountered at day 7 in the F_1 than in the parental strain. This difference was as pronounced in the immunologically crippled F_1 hybrid animals. In vitro results indicated that A cells are cytotoxic to the target cells against which they are tolerant in the presence of phytohemagglutinin. These findings indicate that contact-induced cytotoxicity is caused by target cell contact with lymphoid cells carrying foreign histocompatibility antigens and that the reaction is independent of immunological recognition of the lymphoid cells. (BBB)

638 ANTIGEN-INDUCED REFRACTORY PERIOD OF ADOPTIVE TRANSFER. Rose, Noel R.; Twarog, Frank J. (State Univ. of New York, Buffalo). Transplant. Proc., 1: No. 1, Pt. 2, 564-6 (Mar. 1969).

From 2nd International Congress of the Transplantation Society, New York. See CONF-680922.

The effect of antigen on adoptively transferred cells was studied in donor male C_3H mice that received a primary injection of bovine serum albumin (BSA) in complete Freund adjuvant. Five weeks later they received a booster of BSA without adjuvant. A spleen and lymph node cell pool was transferred to syngeneic irradiated (400 R) recipients, 1 to 30 days later. No antibody was detected in recipients of cells from donors boostered 11, 15, or 20 days before transfer. Challenge of these animals 28 days after the transfer with a subimmunogenic dose of BSA resulted in prompt appearance of BSA antibodies indicating that cell death could not explain the absence of antibody formation. It is proposed that this period of refractoriness was induced by the second exposure of donor animals to the immunizing antigen. C_3H mice immunized with mouse thyroid extract (MTE) elaborated high titers of antibody directed against that antigen. In contrast to the results obtained with BSA, transfer of spleen and lymph node cells was not followed by spontaneous appearance of MTE antibodies in the recipients. When doubly immunized donors were boostered 3 days before transfer with an aqueous dose of antigen (MTE + BSA), recipients showed a reversal of the results obtained when nonboostered donors were used. BSA antibody was suppressed whereas MTE-antibody formation was enhanced in recipients under these experimental conditions. These experimental models illustrated different effects of antigen on adoptive transfer. In the first model using mice sensitized to a single antigen, the second injection of antigen apparently depletes transferred lymphoid tissue of antibody-forming but not memory cells. In the second model using doubly sensitized donors there are two effects of antigen booster. On the one hand, there is depletion of cells forming antibody to BSA, perhaps through antigenic competition. On the other hand, an enhancement of antibody formation to MTE in recipient mice was seen. (BBB)

639 SPECIFICITY OF THE IN VITRO RESPONSE OF ANTIGEN-SENSITIVE UNITS TO TWO ANTIGENS. Osoba, David (Ontario Cancer Inst., Toronto). Transplant. Proc., 1: No. 1, Pt. 2, 567-9 (Mar. 1969).

From 2nd International Congress of the Transplantation Society, New York. See CONF-680922.

To study specificity of the in vitro response of antibody-producing cell precursors experiments were performed in which a single precursor was exposed simultaneously to two non-crossreacting antigens. Spleen cells from unimmunized CBA mice were mixed with either sheep red blood cells (SRBC), or chicken red blood cells (CRBC), or both. The peak response to either SRBC or CRBC occurred on the 4th day of culture. Small numbers of spleen cells, i.e., 10^7 or less, when mixed with SRBC or CRBC, failed to give a plaque-forming cell (PFC) response. However, when 2×10^7 irradiated spleen cells (1000 rad) were included in the cultures, smaller numbers of unirradiated spleen cells now gave rise to PFC responses which peaked on the 4th day. Irradiated spleen cells did not themselves produce a PFC response. As the number of normal spleen cells cultured was increased, there was linear increase in the mean number of PFC per culture. The frequency of precursors to SRBC was about 1 per 2 to 3×10^6 spleen cells, while the number responding to CRBC was about 1 per 0.5 to 1×10^6 cells. This frequency was the same when both SRBC and CRBC were present simultaneously. These different frequencies indicate that the precursors for these two antigens belong to separate and independent populations of cells. Single precursors of antibody-producing cells are highly differentiated. Antigen merely serves as a trigger to induce proliferation and the production of detectable amounts of antibody. (BBB)

640 SKIN ALLOGRAFT SURVIVAL IN LYMPHOCYTE-DEPLETED CALVES. Chanana, A. D.; Cronkite, E. P.; Joel, D. D.; Schiffer, L. M. (Brookhaven National Lab., Upton, N. Y.). Transplant. Proc., 1: No. 1, Pt. 2, 583-5 (Mar. 1969).

From 2nd International Congress of the Transplantation Society, New York. See CONF-680922.

Extracorporeal irradiation of the blood (ECIB), producing marked and sustained blood lymphocytopenia, was used to prolong skin allograft survival in calves. The results obtained with ECIB in normal calves were compared to those obtained in thymectomized calves receiving ECIB and by combined Imuran and ECIB therapy.

Most calves received ECIB to 10 blood volumes/day for 5 to 6 days, followed by skin grafting. Postgraft ECIB to 5 blood volumes a day was continued until the skin allografts rejected. The transit dose averaged 633 rad. Repetitive, daily ECIB, despite the production of marked and sustained lymphocytopenia, resulted in only modest prolongation of skin allograft survival. Thymectomy in 56- to 205-day-old calves resulted in lymphocytopenia, and ECIB in thymectomized calves produced a further marked drop in blood lymphocytes, but the addition of thymectomy did not improve the skin allograft survival as obtained by ECIB treatment alone. Imuran, even in small nontoxic doses, had complementary effects in prolonging skin allograft survival when combined with ECIB. (BBB)

641 ALLOGRAFT IMMUNITY PRODUCED WITH SKIN ISOGRAFTS FROM IMMUNOLOGICALLY TOLERANT MICE. Steinmuller, David (Univ. of Utah, Salt Lake City). Transplant. Proc., 1: No. 1, Pt. 2, 593-6(Mar. 1969).

From 2nd International Congress of the Transplantation Society, New York. See CONF-680922.

The possible immunizing ability of leukocytes or other adventitious cells found in transplanted tissue was investigated. Skin isografts that had been transplanted to specifically tolerant mice were retransplanted to nontolerant mice of the same highly inbred strain. When these recipients subsequently were challenged with primary skin allografts, many rejected the grafts in the accelerated fashion indicative of strong preexisting transplantation immunity. Inflammatory cells present in the isografts at the time of retransplantation presumably were carried into the secondary recipients. Isografts from radiation-induced chimeras immunized in a much higher frequency than those from mice made tolerant neonatally, reflecting the significantly higher levels of leukocyte chimerism achieved with adult radiation-produced as opposed to neonatally produced tolerance. With both neonatally produced and radiation-produced tolerance, isografts taken from an area of inflamed skin immunized better than isografts of normal skin. Adult strain A mice were made tolerant to the C3H strain by 850 R of x rays followed by inoculation of (A × C3H) F_1 spleen cells. Immunity against C3H was produced with 98% normal noninflamed skin isografts from these radiation chimeras as compared to 52% normal isografts from the A mice made tolerant to C3H at birth. Thus, the leukocytes of the radiation chimeras were nearly all (A × C3H) F_1 cells whereas those of the neonatally produced tolerant mice were less than 10%. Strain A mice tolerant to C3H were made leukopenic by whole-body x irradiation and then tested for their ability to provide immunizing isografts. This ability was not affected by 450 R, but after 900 R the number of positive donors was reduced 56%. (BBB)

642 REGENERATIVE POTENTIAL OF IMMUNOCOMPETENT CELLS. III. RECOVERY OF PRIMARY ANTIBODY-FORMING POTENTIAL FROM X-IRRADIATION. THE ROLE OF THE THYMUS. Nettesheim, P.; Williams, M. L.; Hammons, Anna S. (Oak Ridge National Lab., Tenn.). J. Immunol., 103: 505-18(Sept. 1969).

The experimental data are consistent with the notion that the immune progenitor cell pool initially stimulated in the primary antibody response is distinct from that stimulated in the secondary or anamnestic response. A major factor responsible for the long-lasting immunologic inadequacy of irradiated animals appears to be a chronic deficiency in immunocompetent cells. The capacity to form 7 S antibody was more heavily suppressed by x irradiation than was the capacity to form 19 S antibody. This preferential suppression of the 7 S response was seen throughout the recovery phase. In thymectomized mice irradiated with 850 R and treated with isologous bone marrow, recovery of the 7 S antibody response was virtually abolished, whereas the 19 S hemagglutinin response recovered substantially. Recovery of antibody-forming capacity from x ray exposures as high as 1000 R does not require the presence of the thymus; primarily the rate of recovery appears to be thymus-dependent. These observations were made in two different mouse strains with rat and sheep red blood cells used as test antigens. Recovery from antigen competition was found to be independent of the thymus. (auth)

643 STUDY OF THE ANTIGENIC STRUCTURE OF TWO RADIOLYMPHOSARCOMAS OF THE MOUSE. Mazurek, C.; Estienne, E. (Fondation Curie, Paris). Bull. Cancer, 55: 503-10(1968). (In French).

Two strains of transplantable radioinduced leukemia were studied. One (LS-3762/C57Bl) was induced in C57Bl mice and the other (LS-3073/XVII) in mice of the XVII strain. The transplanted lymphosarcomas will grow only in mice of the isogeneic strains. A study was made of the cytotoxic effects of an antiserum produced in C57BL mice by inoculation of cells from the LS3073/XVII radiolymphosarcoma. This antiserum inhibited tumor growth in vivo, when it was injected by the intravenous route, the tumor being grafted by the subcutaneous route, and in vitro, when the cells were incubated for 1 hr at 20°C before being transplanted. After adsorption on mouse XVII red cells, this serum was only active in vivo. This antiserum inhibited the growth of a C57Bl radiolymphosarcoma. The results indicated that there is an antigen X and another antigen common to the two radiolymphosarcomas but that might be different from the TL antigen. (BBB)

644 HOST RESISTANCE AGAINST ISOTRANSPLANTATION OF LYMPHOMAS INDUCED BY THE RADIATION LEUKEMIA VIRUS. Haran-Ghera, N. (Weizmann Inst. of Science, Rehovoth, Israel). Nature (London), 222: 992-3(June 7, 1969).

A leukemogenic virus was isolated from radioinduced lymphomas in C57/BL mice and from various tissues collected 5 to 10 days after irradiation. This virus was apparently present in the non-irradiated animals, irradiation releasing it and contributing in other ways to leukemogenesis. The present study examined the possibility of building up resistance in isologous mice against lymphomas induced by the irradiation virus by protecting the animals with the virus. The virus was isolated from irradiated lymphoid tumors. Newborn mice were injected intraperitoneally with cell free extract containing the virus, and the animals were challenged 30 days later with doses of leukemic cells taken from isologous lymphoid tumors induced by the same virus and injected subcutaneously. In two of the three groups tested inoculation of the virus into the newborn mice induced resistance to further isotransplantation of leukemic cells. The virus was also introduced into adult mice by either the subcutaneous route, or directly into the thymus. With subcutaneous inoculation all mice developed tumors, but with direct thymus injection there were no takes, indicating that the route of virus administration is important for inducing immunization. Similar results were obtained with spleen injections, but the kidney was found to be a partially effective injection site. It is believed that in order to obtain host immunization the virus must first reach the thymus. (UK)

645 LEVEL OF THE HUMAN PLASMA SOMATOTROPHIC HORMONE (STH) BY THE ^{125}I RADIO-IMMUNOLOGICAL ASSAY TECHNIQUE. Sizonenko, P. C.; Job, J. C.; Michel, R. (Hopital Saint-Vincent de Paul, Paris). Rev. Fr. Etud. Clin. Biol., 13: 407-13(Apr. 1968). (In French).

Iodination of human growth hormone (HGH) was performed with carrier and reducing agent-free ^{125}I (IMS-3) in aqueous solution. Yields of iodination and percentage of damage radioactive HGH were estimated by electrophoresis on Whatman 3 MM paper. The procedure seemed to produce a valuable radioactive HGH with less iodination damage than with ^{131}I. Purification of HGH was performed by gel-filtration on Sephadex G-50 column, followed by Sephadex G-100. Several protein eluates were tested in two ways: quality of purification of HGH was controlled by electrophoresis; immunologic activity of radioactive HGH versus an anti-HGH antibody in excess of an incubation of one hour as suggested by Yalow and Berson. Eluates with pure radioactive HGH showing a normal immunological behavior were kept for 3 to 4 weeks at −20°C. Checks of purity and immunologic standing of the radioactive preparation were made every week before using radioactive hormone for incubation of plasma. Pure preparation remains unchanged for 3 to 4 weeks while on the other hand a preparation containing a minor amount of damaged hormone kept under the same conditions for 3 weeks showed an increase of the damage. A kind of autocatalytic decomposition may have occurred. Incubation of standards of HGH and of plasmas were made according to the procedure of Hunter and Greenwood. Separation of bound radioactive HGH and free radioactive HGH was made by chromato-electrophoresis on Whatman 3 MM. Sensibility of the method did not undergo 1 mμg/ml. Reproductibility is 80 p. 100 with plasmas diluted not less than 1/10, otherwise an important incubation damage occurs. Radioimmunoassays of HGH were made in plasmas of normal children, idiopathic and hypopituitary dwarfism during an insulinic hypoglycemia test. Several cases of cranio-pharyngiomas showed no HGH present in the plasma and no rise during the hypoglycemic test. Some idiopathic hypopituitary dwarfs with TSH or A.C.T.H. deficiency have normal HGH levels at resting time but no rise during the hypoglycemia. Idiopathic dwarfisms have showed normal resting plasma values of HGH and normal rise under hypoglycemic stimulation. (auth)

646 HETEROTOPIC HOMOTRANSPLANTATION OF THE HEART IN THE RAT: STUDY OF THE INITIAL REJECTION STATE AND INFLUENCE OF STORAGE. Bui-Mong-Hung; Liacopoulos, P.; Vigano, M.; Leandri, J. (Hoptial Broussais, Paris). Eur. Surg. Res., 1: 103-14(1969). (In French).

Ionizing radiation was used to induce immune tolerance in rats acting as recipients of cardiac homografts. Wistar rats were irradiated with 700 R and injected with 95×10^6 bone marrow or

spleen cells of the heart-donor Fisher rats before intra-abdominal transplantation of the heart. A simple technique for heterotopic cardiac transplantation was used with an end-to-side aorto-aortic anastomosis. When used on inbred strain rats, this technique appeared to be a valuable procedure for testing either storage processes or immunosuppressive methods, such as irradiation. However, some histological alterations arose from the technique itself, namely heart graft trauma and anoxia. Moreover heterotopia per se may induce additional histological changes. The rejection process seemed to occur as early as the 36th hour. The cellular reaction started in subepicardial and subendocardial layers; later it invaded the whole heart, producing extensive necrotic areas. Use of irradiation and bone marrow grafting was not effective in the rat for producing immune tolerance, contrary to results in the mouse. Storage of hearts under hyperbaric conditions (5 atm, 100% oxygen) was also evaluated. A decompression schedule was considered as an important factor of storage, to be used with the hyperbaric process. Progressive, anaphrotropic decompression gave better results than stepwise decompression. Nevertheless, hyperbaric oxygen and hypothermia did not seem to protect satisfactorily the rat heart graft for long periods. (BBB)

647 BONE MARROW CONFERENCE. PRESERVATION OF HEMOPOIETIC, PERIPHERAL BLOOD, AND LYMPHATIC TISSUE ELEMENTS, DECEMBER 5–6, 1968, NEW YORK, NEW YORK. Congdon, C. C. (ed.). Exp. Hematol., No. 18, 1-55 (1969). (CONF-681213-(Absts.)).

Abstracts of papers given at the winter Bone Marrow conference on December 5 and 6, 1968 are presented. The major topic of the papers was the preservation of bone marrow and related tissues. Twenty-three abstracts are included. (E.R.B.)

648 CHANGE IN THE RADIOSENSITIVITY OF A CELL POPULATION OF LYMPHOID TISSUE AGAINST A BACKGROUND OF STIMULATION OF IMMUNOGENESIS. Mozgova, L. A.; Bibikhin, L. N.; Kartasheva, A. L.; Poverennyi, A. M. (Inst. of Medical Radiology, Obninsk, USSR). Radiobiologiya, 8: 704-8 (1968). (In Russian).

The radiosensitivity of lymphoid cells of the spleen and thymus was studied against a background of nonspecific and specific stimulation of immunogenesis, varying according to the accumulation of polydeoxyribonucleotide and the change in the hemolysin titer. It was established that the radiosensitivity of a population of lymphoid cells, playing the basic role in the immune responses, is especially distinctly increased in the first days after nonspecific stimulation. The data obtained indicated that the use of ionizing radiation during these periods may lead to the most effective suppression of immunogenesis, a conclusion that merits further study. (JPRS)

649 RADIOIMMUNOASSAY DETERMINATION OF LUTEINIZING HORMONE DURING THE ESTROUS CYCLE OF THE RAT. Monroe, Scott E.; Rebar, Robert W.; Gay, Vernon L.; Midgley, A. Rees Jr. (Univ. of Michigan, Ann Arbor). Endocrinology, 85: 720-4 (Oct. 1969).

The concentrations of luteinizing hormone (LH) in sera and pituitary glands from normal female rats were measured by radioimmunoassay. In both 4- and 5-day cycling rats, concentrations of serum LH were at least 50-fold greater on the afternoon of proestrus than at any other time in the estrous cycle. No significant elevation in serum LH concentration was observed during the afternoon of diestrus. In animals exsanguinated on the afternoon of proestrus, elevated concentrations of serum LH were found as early as 1:00 pm and as late as 8:00 pm, but the highest incidence of elevated concentrations was observed between 3:00 and 6:00 pm. In individual rats bled repeatedly by cardiac puncture on the afternoon of proestrus, concentrations of serum LH increased and decreased at about the same rate with the period of maximal LH release occurring over a 1 to 3 hr interval. In some animals, the rate at which serum LH concentrations decreased approximated the disappearance rate for endogenous LH in the hypophysectomized proestrous rat. A significant decrease in pituitary LH concentration occurred between the morning and evening of proestrus. (auth)

Ecology

Refer also to abstracts 162, 690, 707, 827, and 1972.

650 (RLO-2047-5) COLUMBIA RIVER STUDIES. Annual Progress Report, 1968-1969. Seymour, Allyn H. (Washington Univ., Seattle. Lab. of Radiation Ecology). June 27, 1969. Contract AT(45-1)-2047. 92p. Dep. CFSTI.

Seven abstracts were prepared. Radioisotope studies were conducted with waters of the Columbia River and its marine life. Laboratory studies were also performed. The effects of the Hanford reactors were investigated. One abstract appeared in NSA 23: 50399. (H.B.G.)

For abstracts of individual papers see: 651, 652, 690, 707, 827, and 828.

651 (RLO-2047-5, App. B) EFFECTS OF $^{90}Sr + ^{90}Y$, ^{65}Zn, AND ^{51}Cr ON THE LARVAE OF THE PACIFIC OYSTER, CRASSOSTREA GIGAS. A Summary. Nelson, Victor A. (Washington Univ., Seattle. Lab. of Radiation Ecology). 28p.

Larvae of the Pacific oyster, Crassostrea gigas, were exposed to radionuclides and stable elements, and the concentration determined that induced impairment of development within 48 hr. Stable chromium had no effect at any of the levels tested. The relation between the experimental results and the radionuclide concentrations now present in the marine environment is discussed. It is concluded that the concentrations of radionuclides now found in Willapa Bay would have to increase a millionfold before effects upon oyster larvae would be expected. (H.B.G.)

652 (RLO-2047-5, App. F) ^{65}Zn MONITORING PROGRAM. (Washington Univ., Seattle. Lab. of Radiation Ecology). 4p.

The activity of ^{65}Zn was determined in various sea animals, especially mussels, in the outflow region of the Columbia river. The amount of ^{65}Zn depended on the number of reactors operating at Hanford. (H.B.G.)

653 (UCRL-50718, pp 43-56) RADIOECOLOGICAL STUDIES. Koranda, John J.; Martin, John R.; Wikkerink, Robert W.; Stuart, Marshall L. (California Univ., Livermore. Lawrence Radiation Lab.).

A 31 kilo nuclear cratering detonation was executed at the Nevada test site. During cavity rupture and venting, radionuclides were released and deposited with fallout in the area adjacent to ground zero. Of the nuclides, tritium and ^{181}W were measured in soil samples and in small mammals native to the area. At about 3000 feet from ground zero, tritium content of soil water was roughly 10^5 disintegration per minute per milliliter. Body water of mammals showed the same activity. Forty days after detonation, ^{181}W values were 0.30 μCi/gm of bone. (H.B.G.)

654 (UCRL-50718, pp 57-8) BIOLOGICAL AVAILABILITY TO DAIRY COWS OF RADIONUCLIDES IN SCHOONER DEBRIS. Potter, Gilbert D.; McIntyre, David R.; Vattuone, Gerald M. (California Univ., Livermore. Lawrence Radiation Lab.).

During a 31 kiloton cratering detonation, 200 grams of debris were collected in a fallout tray and were fed to a lactating cow. Milk, blood, urine, and feces were collected for seven days. The biological samples were analyzed on a 2048-channel analyzer. (H.B.G.)

655 (UCRL-50718, pp 65-9) STUDIES IN AQUATIC BIOLOGY. Harrison, Florence L.; Ott, Jane M.; Quinn, Dorothy J. (California Univ., Livermore. Lawrence Radiation Lab.).

Debris was collected from several locations around ground zero of a 31 kiloton nuclear cratering explosion. The debris was analyzed as to particle size distribution and as to leachability in pond water and seawater. The biological availability of the fallout debris radionuclides to freshwater and marine mollusks was investigated. (H.B.G.)

Genetics and Cytogenetics

Refer also to abstracts 819 and 930.

656 (NYO-2902-13) MUTATIONS TO SEX-LINKED LETHALS IN THE MOUSE. Period Covered: August 15, 1968–August 15, 1969. Caspari, Ernst W.; Eicher, Eva M. (Rochester Univ., N. Y.). Contract AT(30-1)-2902. 39p. Dep. CFSTI.

Radioinduced mutations in male mice with a x-a translocation were studied. Males fd/Y were exposed to 350 R x rays and mated to FCC females (FCC is a hybrid of $C_3Hpp \times CBApp$). Their offspring were scored at birth for sex, eye colors, and litter size. They were compared to litters produced by the same males crossed to the same females before irradiation, and to the offspring of +/Y males, mostly sibs of the treated males One fd/Y male was always paired with one +/Y male. In two independent experiments the sex ratio in the offspring of irradiated males was distorted in favor of the male sex. In both experiments the difference between the offspring of the same males before and after irradiation was significant at the 0.05 level. The normal XY males showed a difference in the same direction but it was not significant. The higher sensitivity of the X^{fd}-chromosome is not due to a stronger reaction on mutations induced in the genetic background, since the sex ratio was not distorted in crosses of irradiated +/Y males to fd/+ females. Irradiation, therefore, affects the X^{fd}-

chromosome directly. Hypotheses to explain the effect are proposed. Higher sensitivity of X^{fd} as compared to a normal X-chromosome was indicated by an increased induction of tumors in the irradiated area in fd/Y animals. The sizes of litters produced by irradiated fd/Y and +/Y males were reduced. Twelve pink-eyed exceptional females obtained from irradiated and control males were investigated genetically and cytologically. Eleven were XO while the twelfth was a cytological mosaic. No evidence for the existence of pink-eyed females due to cell lethals in the X^{fd}-chromosome was found. The mutation c^3 that is assumed to be a deletion involving the c locus was investigated with relation to the X^{fd}-chromosome. X^{fd}/X; I^{Dt}/c^3 animals were obtained and showed a low degree of mosaicism. This finding showed that cells with a homozygous deletion in which the covering X^{fd} chromosome was turned off were not completely replaced by cells in which the X^{n}-chromosome was turned off. Evidence is presented that suggests that inactivation of the autosomal I piece inserted into the X^{fd}-chromosomes may proceed from both sides of the X-chromosome. There must be at least two inactivation centers present. (M.M.B.)

657 (NYO-3797-8) [X-RAY EXAMINATION OF BACTERIOPHAGE FUNCTION]. Three Year Comprehensive Progress Report. Freifelder, David (Brandeis Univ., Waltham, Mass.). Sept. 26, 1969. Contract AT(30-1)-3797. 18p. Dep. CFSTI.

Results of research on radiobiological mechanisms at the molecular level in phages are reported. The present state of knowledge in this area, its significance, and future approaches are discussed. Research reported includes mechanisms of x-radioinduced inactivation, special mechanisms of DNA base damage repair in T4, the molecular basis for radioprotection by glycerol and histidine, the rate of x-radioinduced single-stranded DNA breaks in Escherichia coli, determination of the bond broken in the DNA sugar phosphate backbone by x irradiation, use of x rays in DNA molecular weight determinations and confirmation of the Campbell prophage insertion model, use of x-radioinduced single-strand breaks for study of DNA double helix stability, properties of the system active in the repair of uv-radioinduced damage, the effects of x radiation on the process of injection of the DNA of phase λ into E. coli, and the nature of the dead phages in populations of λ. (M.M.B.)

658 EFFECTS OF CERTAIN CHEMICAL COMPOUNDS ON THE CHROMOSOMES OF CANCER CELLS. Labzina, N. G. (Inst. of Medical Radiology, Obninsk, USSR). Radiobiologiya, 9: 510-17(July-Aug. 1969). (In Russian).

Cells of the strains: Ehrlich's ascites carcinoma (EAC), NK/ly, and OYa were subjected to the influence of x irradiation and various chemical substances in vitro. After the treatment, EAC and NK/ly cells were injected intraperitoneally into mice, while OYa cells were administered to rats. The chromosome aberrations (CA) were analyzed 20 to 21 hrs after the injection.

659 LINKAGE GROUP-KARYOTYPE CORRELATION IN THE HOUSE FLY, MUSCA DOMESTICA L., CONFIRMED BY CYTOLOGICAL ANALYSIS OF X-RAY INDUCED Y-AUTOSOMAL TRANSLOCATIONS. Wagoner, Dale E. (Dept. of Agriculture, N. Dak.). Genetics, 62: 115-21(May 1969).

Cytological analysis of x-ray induced Y-autosomal translocations in the house fly, Musca domestica L., confirmed the linkage group-karyotype correlation reported by Wagoner. Perje's method of numbering the chromosomes was used (where X and Y represent the sex chromosomes and Roman numerals I-V represent the autosomes starting with the longest pair and ending with the shortest). The following relations were confirmed: The Rl and ac mutants are located on chromosome I; the ar and car mutants are located on chromosome II; the bwb mutant is on chromosome III; the ct and ye mutants are on chromosome IV; and the ocra mutant is on chromosome V. A case (or cases) of nondisjunction in a Y-IV translocation stock is hypothesized to have produced males with two X's (an X, X, Y^{IV}, IV^{Y}, IV chromosome complement) instead of the normal X chromosome. The males containing XX replaced the males containing one X in subsequent generations. (auth)

660 STUDIES ON EARLY HEADING MUTATIONS OF RICE. Kawai, Takeshi; Sato, Hisao (National Inst. of Agricultural Sciences, Tokyo). Nogyo Gijutsu Kenkyusho Hokoku, D, No. 20, 1-33(Mar. 1969).

Dry seed of a rice variety, Norin No. 8, was treated with x ray, pile neutron of γ ray, and early heading plants were screened from R_1 strains (R_1 spike progenies). Heading date and other characteristics, including yield capacity, were investigated in 1960 to 1966 on progenies of the screened plants and also mutant strains that were obtained in other mutation experiments on the variety. The results obtained were as follows: Significantly early heading mutations were induced at a rate of 1.7 per 100 R_2 strains (23 mutations per 1322 R_2 strains) by the above treatments. When early heading mutations accompanying reduced fertility were excluded, the frequency was 1.4 per 100 R_2 strains (18 mutations per 1322 R_2 strains). Because of the small number of obtained early heading mutations, relationship between radiation dose and mutation frequency and also dependence of mutation frequency on radiation kind were not clarified. The characteristics of fifty nine significantly earlier heading mutant strains, obtained from the above treatments and other mutation experiments, were investigated. Ear emergence was 1.3 to 18.4 days earlier than the original variety. Grain yield was reduced in most of the strains and ranged between 53% and 104% of the original variety. Calculated grain yield as a product of panicle weight (measured on the tallest panicle of each plant) and panicle number was larger than the observed yield in many of the mutant strains, indicating that weight of panicles other than that on the tallest stem, relative to the tallest panicle, was smaller in the mutant strains than in the original variety. Frequency of mutations three days or more earlier in heading date and with grain yield of 90% or more of the original variety, that could be considered to possess possibility of direct use in practical breeding, was 2.3 per 1000 R_1 strains. From the results, breeding work necessary for obtaining early heading variety by utilizing induced mutations was suggested. (auth) (FMM)

661 GENETIC EFFECTS PRODUCED BY THE SPACE ENVIRONMENT. Oster, Irwin I. (Bowling Green State Univ., Ohio). pp 95-6 of Life Sciences and Space Research VII. Vishniac, W.; Favorite, F. G. (eds.). Amsterdam, North-Holland Publishing Co., 1969.

From 11th Plenary Meeting, Tokyo, Japan. See CONF-680530-(Vol.7); From Symposium on Biological Effects of Radiation in Space, Tokyo, Japan. See CONF-680555.

The ability to observe several parameters in the genetic material of both somatic and reproductive cells of the same organism subjected to orbital flight offers distinct advantages for assessing and understanding the impact of the space environment on biological matter in general. As often stressed by our Soviet colleagues, Drosophila melanogaster is very well suited for such investigations. Synthesized from some of the most refined stocks available for multicellular animals, Drosophila larvae containing a preponderance of actively dividing and metabolizing cells and older developmental stages containing more mature cells were flown in a satellite (Biosatellite II) for 42 hr to determine the genetic effects of radiation and zero gravity. Part of the material was exposed to several hundred roentgens of gamma radiation from an on-board source while in orbit. Ground-based irradiated and unirradiated individuals served as controls. Cytogenetic analyses have revealed the following results of significance: Radiation interacts with weightlessness to produce more premature aging, chromosome breakage often followed by loss, and recessive lethal mutations in actively growing and metabolizing individuals than in those irradiated on Earth. Some factor, associated with space flight, more than likely weightlessness, is capable of causing improper chromosome separation (nondisjunction) and the formation of chromosomal translocations. While these observations should hold true in general, particularly for dividing versus nondividing cells, a breakdown of the aforementioned results has shown that the extent to which these genetic effects are detectable is largely dependent on the type of tissue or origin. This should be considered carefully when comparisons are made between results obtained with diverse organisms and systems. (auth)

662 X-RAY INDUCTION OF CHROMATID EXCHANGES IN MITOTIC AND G1 CHINESE HAMSTER CELLS PRETREATED WITH COLCEMID. Dewey, W. C.; Miller, H. H. (Colorado State Univ., Fort Collins). Exp. Cell Res., 57: 63-70(Sept. 1969).

Chinese hamster cells were synchronized by selecting mitotic cells from an asychronous population, either with or without a 2-hr pretreatment with Colcemid. In both cases, x irradiation of mitotic cells induced twice as many chromosomal aberrations as irradiation of G1 cells. Without Colcemid pretreatment, 90% of the exchanges induced in mitotic and G1 cells were of the chromosome type. Colcemid pretreatment did not affect the frequency of the chromosome type exchanges, but the treatment increased the total aberration frequency by a factor of 2 to 3 due to an increase in the frequency of deletions and the appearance of chromatid type exchanges (50% of the total). The Colcemid effect is discussed in relation to a reduction in protoplasmic viscosity reported as a result of Colcemid binding to macromolecules. (auth)

663 ENRICHMENT AND ISOLATION OF AUXOTROPHIC MUTANTS OF HYDROGENOMONAS H 16. Reh, M.; Schlegel, H. G. (Univ., Goettingen, Ger.). Arch. Mikrobiol., 67: 99-109 (July 10, 1969). (In German).

To induce auxotrophic mutants, a fructose nutrient solution containing Hydrogenomonas H 16 was irradiated with uv light or treated with two chemical mutagens. To prevent photoreversion,

the uv-irradiated samples were kept in the dark. After treatment with uv radiation at a level that killed 99.99% of the cells, relatively few auxotrophic mutants were isolated. After mutagenesis by nitrous acid about 0.4% and by 1-nitroso-3-nitro-1-methylguanidine 1.5% auxotrophic mutants were found among the survivors. To increase the mutant yield an enrichment method was elaborated. The penicillin technique was modified by replacing penicillin by colistin, since penicillin is ineffective for Hydrogenomonas H 16. The incubation of 10^8 cells/ml under growth conditions in the presence of 50 μg colistin/ml for 10 hr was found effective; during a model experiment 88% of the nongrowing auxotrophic cells and only 0.09% of the growing wild type cells survived. Altogether, 214 mutants were isolated and nutritionally characterized. In addition to auxotrophs many mutants were isolated that lacked the ability to utilize fructose. Some strains requiring isoleucine, or isoleucine + valine, were characterized. On the basis of results of cross-feeding experiments and of enzyme assays it is concluded that the biosynthetic pathways for isoleucine and valine in Hydrogenomonas are the same as in other bacteria. (BBB)

664 UV-SENSITIVE MUTANTS INCREASING MITOTIC CROSSING-OVER IN ASPERGILLUS NIDULANS. Shanfield, Bernice; Kaefer, Etta (McGill Univ., Montreal). Mutat. Res., 7: 485-7(May-June 1969).

Two mutants with increased sensitivity to uv were isolated from uv-irradiated populations of Aspergillus nidulans. They were both recessive and appeared to be non-complementing alleles at a new gene location. They were much more sensitive to N-methyl-N′-nitrosoguanadine than the wild type was. Meiotic crossing-over appeared to be unaffected by the mutations but mitotic crossing-over was enhanced. (M.M.B.)

665 SEX PROPORTION IN SWINE AFTER PATERNAL X-IRRADIATION. Mullaney, P. D.; Cox, D. F. (Iowa State Univ., Ames). Contract AT(11-1)-707. Mutat. Res., 7: 482-4(May-June 1969).

The effects of spermatogonial irradiation on the sex ratio in Duroc and Hampshire pigs were investigated. One male of a littermate of brothers was exposed to 300 R of x radiation directed to the center of the testes at approximately 100 R/min. The other member of the pair was not exposed. The data were from 3053 litters of pigs over a period of 6 yr. The males were not mated until at least 5 months after irradiation. Data were obtained on the proportion of males born (sex proportion) in litters derived from either irradiated maternal grandsires, irradiated sires, or unirradiated control boars. The pooled results showed that the sex proportion of litters descended from irradiated boars averaged 0.005 higher than in the control litters. This difference was negligible and not significant at the 5% level. (M.M.B.)

666 CO-MUTAGENESIS: AN INTERPRETATION OF THE EFFECT OF POST-IRRADIATION TREATMENT WITH BASE ANALOGUES IN THE SILKWORM. Murakami, Akio; Ito, Takashi (Bowling Green State Univ., Ohio). Mutat. Res., 7: 479-81 (May-June 1969).

It was reported that in silkworm germ cells the production of radioinduced egg-color mutation was enhanced several times by post-irradiation treatment with base analogues. The following explanation for this enhancement effect is proposed: radioinduced single strand breaks initiate the degradation of DNA segments and subsequent repair resynthesis, and 5-bromodeoxyuridine is incorporated in place of thymine during the course of repair resynthesis into DNA segments. The incorporation of 5-bromodeoxyuridine leads to mutation of the base-analogue type during the repair synthesis itself and during later replications. (M.M.B.)

667 THE DOSE-DEPENDENCE OF X-CHROMOSOME LOSS INDUCED BY X-RAYS IN MATURE OOCYTES OF DROSOPHILA MELANOGASTER. Traut, H.; Scheid, W. (Univ., Muenster, Ger.). Mutat. Res., 7: 471-4(May-June 1969).

Experiments were conducted on loss of the X-chromosome in Drosophila melanogaster induced by x irradiation of mature oocytes (stage 14). It was found that the frequency of loss increased faster than the dose (100, 200, 300, and 400 R). A genetic and cytological investigation of deletions of the X-chromosome induced by irradiation (400 R) of the mature oocytes was also made. The results indicated that the departure of dose-dependence of x-chromosome loss from linearity could not be explained by the inclusion of large deletions simulating loss of the entire chromosome. (M.M.B.)

668 SUSPECTED MUTANT OF AGROBACTERIUM TUMEFACIENS WITH AN ALTERED DNA. van der Plaat, J. B.; Vernie, L. N.; de Ley, J. (Technological Univ., Delft, Netherlands. State Univ., Ghent). Mutat. Res., 7: 466-8(May-June 1969).

A bacterial strain, M39, was reported to be a radioinduced mutant of Agrobacterium tumefaciens with altered DNA base composition. Unsuccessful attempts were made to isolate uv-radioinduced revertants of M39. Efforts to isolate additional mutants with altered base composition from uv-irradiated populations of A. tumefaciens were also unsuccessful. Since it was suggested that M39 represented a contaminant of the original culture of A. tumefaciens rather than a mutant, a biochemical investigation was undertaken for clarification of genetic relationships. Strain M39 differed from strains of A. tumefaciens in cell wall antigens and sugars, cytochrome oxidase activity, pathogenicity, uv-radiosensitivity, and dye and antibiotic sensitivity. Hybridization experiments did not reveal as much genetic homology with A. tumefaciens strains (6.5% and 7.7%) as with Alcaligenes denitrificans (34%). It was concluded that M39 may have originated as a contaminant. (M.M.B.)

669 TRANSDUCING BACTERIOPHAGE FOR BACILLUS CEREUS. Thorne, Curtis B. (Univ. of Massachusetts, Amherst). J. Virol., 2: 657-662(July 1968).

A phage, designated CP-51, that carries out generalized transduction in Bacillus cereus 569 was isolated from soil. All uv-radioinduced auxotrophic mutants tested, those requiring tryptophan, histidine, leucine, isoleucine, methionine, or phenylalanine, were transduced to prototrophy. The phage was extremely unstable when stored at 2 to 4 C, but stability was enhanced by storage at higher temperatures. The optimal temperature of those tested for maintenance of plaque-forming units was 15 C. (auth)

670 ESCHERICHIA COLI RAS LOCUS: ITS INVOLVEMENT IN RADIATION REPAIR. Walker, James R. (Univ. of Texas, Austin). J. Bacteriol., 99: 713-19(Sept. 1969).

There are several classes of Escherichia coli mutants defective in radiation repair. These include strains defective in pyrimidine dimer excision, in photoreactivation, in recombination, in repair of x-ray damage, and ultraviolet (uv)-conditional mutants that do not divide after uv. Another mutant (ras^-) was isolated. The ras^- has increased uv sensitivity, but only slightly increased x-ray sensitivity (1.5-fold increase). Ability to effect genetic recombination, to reactivate irradiated bacteriophage T1, and to be photoreactivated is normal. Uv-induced mutation frequency is greatly increased in the mutant. The ras^- apparently lacks the ability to repair some uv damage in the bacterial cell but can repair uv damage to bacteriophage DNA. The ras locus is located between lac and purE on the chromosome map. (auth)

671 COMPLEMENTATION IN NONCONIDIATING MUTANTS OF TRICHODERMA. Weinman-Greenshpan, Dvora; Galun, Esra (Weizmann Inst. of Science, Rehovoth, Israel). J. Bacteriol., 99: 802-6(Sept. 1969).

Nonconidiating (Con^-) mutants were isolated from wild-type and color mutants of the fungus Trichoderma viride Pers. ex Fries. Heterokaryons were easily produced and maintained, and the complementation relations among the Con^- mutants were established. Most Con^- mutants could complement one or more of the other Con^- mutants. When marked Con^- mutants were mixed with marked Con^+ testers, conidiating heterokaryons were formed. The conidia thus obtained produced only the parental type colonies after replating, indicating that nonconidiation is a nuclear characteristic. Allowing two Con^- colonies to meet and produce a heterokaryon, it was found that the migration of nuclei reached a rate of 5 mm per hr, that is several times greater than the rate of hyphal elongation; it was also found that heterokaryosis of a mycelial region preceded its ability to conidiate. (auth)

672 GENETICS OF PSEUDOMONAS. Holloway, B. W. (Monash Univ., Clayton, Victoria). Bacteriol. Rev., 33: 419-43 (Sept. 1969).

The genetic knowledge of Pseudonomas is reviewed. The transduction analysis of linkage has revealed an important difference in gene distribution compared with what is known of other bacteria, and the current study of control mechanisms in Pseudomonas suggests a relation between the distribution of genes and the way in which they are controlled. The further elaboration of recombination techniques for P. putida will enable a much better understanding of the mechanisms by which this and other species can catabolize such a wide range of substrates. It is possible that the Pseudomonas pattern of genetic arrangement and control may represent a picture closer to that occurring in higher organisms, including man. Much remains to be done. New tools are needed, such as the development of a partial diploid structure, analogous to an Escherichia coli F. Other sex factors must be investigated with a view to a further understanding of the mechanism of conjugation, and this information must in turn be used to assess the number, size, and structure of the genetic units comprising the Pseudomonas genome. The role of bacteriophage genome in the overall genetic structure of Pseudomonas needs to be investigated.

At the practical level, the nature of the resistance of this organism to so many deleterious agents remains to be fully understood. (auth) (F.M.M.)

673 COMPARISON OF THE LETHAL EFFECTS OF IONIZING OR UV RADIATIONS WITH THE "SUICIDE EFFECT" OF ^{32}P INCORPORATION ON HAPLOID SACCHAROMYCES CEREVISIAE AND THE RADIOSENSITIVITY OF THE MUTANTS. Hatzfeld, J.; Moustacchi, E. (Institut du Radium-Biologie, Orsay, France). Int. J. Radiat. Biol., 15: 101-13(1969). (In French).

Mutants of haploid yeast sensitive to uv radiation were compared with their wild parents. Comparisons were made of the lethal effects of uv rays, ^{60}Co γ rays, β rays emitted by ^{32}P, and disintegrations of incorporated ^{32}P. The two uv mutants were shown to be 10 and 30 times more sensitive to uv rays and two times more sensitive to ^{32}P disintegrations than the wild parents. The α coefficient of effectiveness of ^{32}P disintegrations was calculated after correction for the effect of β rays. This effect on the different stocks is not negligible; it is parallel to that of ^{60}Co γ rays. The uv mutants differ by one gene only from their wild parents. This gene permits repair in the wild type of a fraction of the ^{32}P lesions. A stage without repair processes for lesions induced by uv would be common for alterations caused by ^{32}P. (tr-auth)

674 SPECIAL FEATURES OF THE MUTAGENIC EFFECT OF RADIATION ON THE SPERMATOGONIA OF THE MOUSE. Pomerantseva, M. D.; Ramaiya, L. K. (Inst. of General Genetics, Moscow). Dokl. Akad. Nauk SSSR, 185: 1157-60(Apr. 11, 1969). (In Russian).

Application of data obtained with mice concerning the genetic effect of radiation on man requires further study of the correlation between dose and mutation of the sex cells. This problem was examined by comparing the dose dependence of the appearance of dominant lethal mutations in spermatogonia and in other cells during the later stages of spermatogenesis; the symmetric translocation yield was also studied at various single and repeated irradiation doses. The start of dominant lethal mutations was determined in spermatozoids, spermatids, spermatocytes and spermatogonia. The animals were exposed to whole-body radiation of 100 to 600 R; only the scrotum was exposed to doses of 900 to 1800 R. It was found that the mutation yield after exposure of the spermatogonia was much lower than after exposure at other stages of spermatogenesis. The embryonic death due to the irradiation of the spermatogonia appears to be connected with symmetric translocations. Fractional exposure yielded fewer deaths than an equivalent single exposure. Thus, the radiosensitivity of the spermatogonia creates a complex evolutionary barrier that protects the organism against a large number of mutations. (TTT)

675 INVESTIGATION OF MUTAGENESIS INDUCED BY ACUTE AND CHRONIC IONIZING IRRADIATION IN POPULATIONS OF CHLORELLA AND CHLAMYDOMONAS. Shevchenko, V. A.; Vizgin, V. P.; Alekseenok, A. Ya.; Kogan, I. G.; Pyatyshev, D. R.; Rogatykh, N. P. (Inst. of General Genetics, Moscow). Genetika, 5: No. 9, 61-73(Sept. 1969). (In Russian).

Natural and induced mutagenesis was investigated in model populations of unicellular green algae, Chlorella and Chlamydomonas. The frequency of mutant cells (affected by morphological, pigment, and dwarf mutations) became stabilized after a long-term cultivation at a level varying from 0.25 to 0.50%. The mutant clones appearing in a population as the result of acute irradiations with x rays are eliminated from the population in the course of a number of cell divisions. In case of a chronic β irradiation (^{90}Sr and ^{90}Y being used as sources of β rays) the frequency of mutant cells in an irradiated population increases in the course of a number of cell generations and is finally stabilized at a definite specific level that is raised with the increasing dose. The elaboration of a mathematical model of dynamics of mutagenesis induced by acute and chronic irradiations in populations of unicellular green algae is in progress. (auth)

676 THE MUTAGENIC EFFECT OF DIFFERENT TYPES OF RADIATION ON SPERMATOGONIA IN MICE. II. THE COMPARISON OF THE MUTAGENIC EFFECT OF SINGLE AND FRACTIONATED EXPOSURE TO IRRADIATIONS ON A SPERMATOGONIA. Pomerantseva, M. D.; Domshlak, M. G. (Inst. of General Genetics, Moscow). Genetika, 5: No. 9, 105-15(Sept. 1969). (In Russian).

The mutagenic effect of x ray administered in single and fractionated doses on the spermatogonia of male mice was studied. The frequency of reciprocal translocations and the yield of dominant lethal mutations were used as the criteria. Translocations were determined cytologically in the spermatocytes at the diakinesis metaphase stage of the first meiotic division. The full doses were 400, 600, 1200, 1800, and 2400 R. These five doses were administered to the male mice in fractions at different intervals and different values of the fractions. It was found, that at the doses 400 and 600 R the yield of mutations was the same after single and fractionated exposures. At a 1200 R total dose the mutation rate was somewhat higher in case of a fractionated exposure as compared to a single exposure. This increase in the mutation rate was most conspicuous when the total 1800 R dose was divided into three fractions and administered at 28 days intervals. Thus it is shown that the fractionation of the dose can increase the yield of mutations as compared with the single exposure, the value of the increase depending on the total dose. (auth)

677 THE STUDY OF CHROMOSOME ABERRATIONS OF THE FIFTH GENERATION OF RADIOMUTANTS OF TYPE (KORNGRASS). Golkhman, B. M. pp 35-43 of Mutagenez Sel'skokhozyaistvennykh Rastenii. Kovarskogo, A. E. (ed.). Kishinev, Izdatel'stvo Kartya Moldovenyaske, 1968. (In Russian).

Investigation of the posterity of corn radiomutants of the variety Korngrass showed that even in the fifth generation there developed chromosome aberrations in much greater quantity than in the control. Each type of mutation had its own characteristic type of chromosome aberration. The quantity of chromosome aberrations was greater in variety teopodnyx than in cultural variety. In teopodnyx, fragment types of aberrations predominated, while in the cultural variety, the bridge type, aberrations predominated. (tr-auth)

678 VARIABILITY IN PEAS CAUSED BY THE EFFECTS OF RADIOACTIVE COBALT AND CHEMICAL MUTAGENS. Ivannikov, S. G.; Moraru, N. I.; Navrotskii, M. A.; Goryuk, M. D. pp 110-22 of Mutagenez Sel'skokhozyaistvennykh Rastenii. Kovarskogo, A. E. (ed.). Kishinev, Izdatel'stvo Kartya Moldovenyaske, 1968. (In Russian).

Study of the experimental mutational process in peas showed that both high and low doses of ionizing radiation caused mutations. The irradiation of material that was treated with chemical mutagens increased the variety of mutations. The sterility of mutants was most often encountered in parthenocarpic forms and the wilting of flowers. Mutant peas differ strongly from initial forms in productivity. (tr-auth)

679 THE OBTAINING OF MUTATIONS INDUCED IN CORN AS A RESULT OF TREATMENT OF SEEDS BY ULTRASOUND. Byrka, S. G. pp 123-30 of Mutagenez Sel'skokhozyaistvennykh Rastenii. Kovarskogo, A. E. (ed.). Kishinev, Izdatel'stvo Kartya Moldovenyaske, 1968. (In Russian).

Mutations were induced in seeds of corn, of the line vir 44, Moldavsky yellow and Kickasskay, by ultrasound. The mutants had marked morphological differences when compared to the controls. The greatest % of mutations was obtained in the second and third generations. High-frequency and low-frequency sound generators produced chlorophyll mutations in the second and to a lesser degree in the first generation of corn pollen of the variety Kickasskay. Exposure for 10 min to high-frequency sound and for 30 min to low-frequency sound led to inactivation of unripened pollen on corn ears. (tr-auth)

680 THE GAMMA-IRRADIATION OF POLLEN OF WHEAT: METHODS OF EXPERIMENTAL MUTAGENESIS. Prosira, B. F. pp 131-8 of Mutagenez Sel'skokhozyaistvennykh Rastenii. Kovarskogo, A. E. (ed.). Kishinev, Izdatel'stvo Kartya Moldovenyaske, 1968. (In Russian).

Gamma irradiation of pollen of winter wheat is one of most effective methods of experimental mutagenesis. Large quantities of mutations are obtained, the frequency and spectrum of which depend upon the genotype. The wide variety of mutations obtained are of interest for the selection of wheat. (tr-auth)

681 INFLUENCE OF IONIZING RADIATION ON FORMATION OF INTERSPECIES HYBRIDS OF WHEAT. Siminel, V. D. pp 139-42 of Mutagenez Sel'skokhozyaistvennykh Rastenii. Kovarskogo, A. E. (ed.). Kishinev, Izdatel'stvo Kartya Moldovenyaske, 1968. (In Russian).

The successive irradiation of seeds of interspecies hybrids of wheat led to the enrichment of the rare botanical combinations for the variety Moldavii. Regarding the breadth of combinations, quantities, and qualities of varieties that arose in the second generation of hybrids, the most important was the interspecies hybrid of varieties Belqkaya 32 x Melyanopus 69. (tr-auth)

682 METHODS OF EXPERIMENTAL MUTAGENESIS. Lysikov, V. N. pp 147-207 of Mutagenez Sel'skokhozyaistvennykh Rastenii. Kovarskogo, A. E. (ed.). Kishinev, Izdatel'stvo Kartya Moldovenyaske, 1968. (In Russian).

A summary of methods used in experimental mutagenesis is presented. Besides general methodology, there are detailed tables regarding both physical and chemical factors involved.

Methods using ionizing radiation for the treatment of unripened generative organs were worked out for the variety Moldavii, and methods for application of chemical mutagens to the standing ears of corn, stigma spraying, and use of Pasteur micropipets, are reviewed. (tr-auth)

For abstracts of individual papers see: 677–682 and 919.

683 MUTAGENEZ SEL'SKOKHOZYAISTVENNYKH RASTENII. (Mutagenesis of Agricultural Plants). Kovarskogo, A. E. (ed.). Kishinev, Izdatel'stvo Kartya Moldovenyaske, 1968. 228p.

Separate abstracts were prepared for seven of the 19 papers included in the book. The other 12 papers are concerned with non-radioinduced mutations in agricultural plants. (E.R.B.)

684 ESTIMATION OF THE GENETIC RISK RESULTING FROM THE TREATMENT OF WOMEN WITH ^{131}I. Sobels, Frederik H. (Univ. of Leiden). Strahlentherapie, 138: 172-7 (Aug. 1969).

Genetic risk estimates are given for possible progeny of a female patient who received two treatments with 50 ml ^{131}I for cancer of the thyroid. They are based on data obtained with mouse females, where low dose rates and fractionation procedures, comparable to those in the case under consideration, reduce the mutation frequency. This leads to an estimate of 3.2 to 6.4 mutations per 100 gametes, or, under the assumption of 10% dominance, to a chance of mutation in the direct progeny of the exposed patient of 3.2 to 6.4 per thousand. The use of radiation-induced mutation frequencies from the mouse to evaluate genetic hazards to progeny of irradiated human females is thought not to entail serious underestimation, because of the far greater resistance of human oocytes to the cell-killing effect of irradiation than of mouse oocytes. Loss of the X-chromosome is estimated at 1%. On the basis of the above estimates it is concluded that permanent sterilization is in such rare, exceptional cases, not indicated. (auth)

685 EFFECT OF CHRONIC IRRADIATION ON BREAD WHEAT. Goud, J. V. (Univ. of Agricultural Sciences, Bangalore, India). Indian J. Genet. Plant Breed., 27: 305-9(1967).

Acute and chronic γ irradiations produced more or less the same type of mutations in bread wheat, Triticum aestivum (N. P. 868), but the mutation frequency was considerably higher (4%) in chronic-irradiated plants (10.7 kR) as compared to acute treatment with 30 kR. (Indian Sci. Abstr.)

686 RADIATION INDUCED GENETIC VARIABILITY IN BARLEY. Ghafoor, Abdul; Bari, G.; Rajput, M. A. (Atomic Energy Agricultural Research Centre, Tandojam, Pakistan). Nucleus (Lahore), 5: 95-100(July-Dec. 1968).

Investigations were undertaken with a view to inducing genetic variability through γ irradiation thus increasing the scope of selection for desirable characters in barley, Hordeum vulgare L. (auth)

687 THIAMINE MUTANTS OF THE CRUCIFER, ARABIDOPSIS. Li, S. L.; Redei, G. P. (Univ. of Missouri, Columbia). Biochem. Genet., 3: 163-70(Apr. 1969).

The small, autogamous, prolific crucifer, Arabidopsis thaliana with five chromosome pairs and a short life cycle (5 weeks) is a diploid well suited for mutation studies. Biochemical mutants were induced by exposing dry seeds to 50 kR of x rays or to 16mM ethyl methane sulfonate (EMS) solution for 15 hr. The seed was then suspended in 0.12% agar solution and planted in soil. The specific requirement of the mutants was identified in test tube cultures on simple, chemically defined media, supplemented according to the needed nutrient. On the basis of the major steps of the thiamine pathway, four loci representing the positions of the blocks were identified during this study. There were 42 mutants (py) blocked in the pathway of the synthesis of the 2,5-dimethyl-4-aminopyrimidine moiety. Eight mutants (tz) were unable to synthesize the 4-methyl-5-beta-hydroxyethylthiazole half or some precursor of it, and 15 mutants at two loci (th-1 and th-2) required the intact thiamine molecule. The mutation frequency for thiamine auxotrophy was only slightly higher after EMS induction compared to that of x rays; thus, the results were combined to give a frequency of induced thiamine auxotrophy per genome of 2.96×10^{-4}. The average induced mutation rate per locus was 0.74×10^{-4}. The spontaneous rate of mutation for thiamine requirement is not known, but it appears to be very low. The frequency of induced mutation at the four loci followed the decreasing order: py, th-1, tz, th-2. Three of the four loci are on different chromosomes (th-2 has not been located yet). The py locus was found to belong to the second linkage group. The th-1 gene was located in the first linkage group, and the tz locus in the fifth. (BBB)

Health Physics and Safety

688 PROVISION OF SOLAR FLARE RADIATION INFORMATION IN SUPPORT OF SUPERSONIC TRANSPORT OPERATIONS: A REVIEW OF DEVELOPMENTS. Buley, L. E. (International Civil Aviation Organization, Montreal). Aerosp. Med., 40: 1134-9(Oct. 1969).

The fundamental difference between the radiobiological problems posed in SST operations by cosmic radiation of galactic origin and by cosmic radiation associated with solar flares (SF) is emphasized. The SF problem is formulated in terms of its biological and operational elements. Expert evaluations of the hazards to SST crew and SST passengers, as groups, and of the potentialities of present-technology on-board and ground-based SF radiation prediction/monitoring/measuring/warning systems, are reviewed. The trend of competent international opinion towards a consensus favoring on-board equipment as the prime means of ensuring biological safety in SST operations is traced. An increasing awareness of the complementary value of predictive information obtained from a ground-based SF forecasting/monitoring system (particularly to flight planning of SST commercial operations) is noted. The possibility of interference with SST R/T communications during SF activity is evaluated. Finally, present and projected action by the International Civil Aviation Organization on this matter is outlined. (auth)

Radioactive Contamination and Decontamination

Refer also to abstracts 264, 651, 653, and 894.

689 (AHSB(S)R-173) RISK EVALUATION FOR STACK RELEASES. Bell, G. D.; Houghton, J. (United Kingdom Atomic Energy Authority, Risley (England). Authority Health and Safety Branch). 1969. 18p. Dep. CFSTI (U. S. Sales Only). UK.

A method of calculating the risk to the population distribution around a reactor site is presented for both ground level and elevated releases. The reactor is assumed to satisfy a control curve of the Farmer type for accidental releases of radioactivity, and the dose-risk relation is assumed to be a simple power law. Results are presented in which iodine is imagined to be released on a number of typical sites. The resulting frequency distributions of thyroid cancer were calculated and are given in the form of frequency-casualty curves (f-N curves). The program 'STRAP II' used in these calculations is described. (auth)

690 (RLO-2047-5, App. A) TOTAL PHOSPHORUS AND ^{32}P IN SEAWATER, INVERTEBRATES, AND ALGAE FROM NORTH HEAD, SEPTEMBER 1965–SEPTEMBER 1966. Isakson, John S.; Seymour, Allyn H. (Washington Univ., Seattle. Lab. of Radiation Ecology). 39p.

Total phosphorus and ^{32}P were studied near the mouth of the Columbia River. The source of the ^{32}P is the cooling water of the Hanford reactors. Analyzed were clams, mussels, barnacles, sea anemones, and six species of algae. In comparison to the surrounding water, the ratio of ^{32}P to total phosphorus was lower in all organisms. (H.B.G.)

691 (UCRL-50718) BIO-MEDICAL DIVISION PRELIMINARY REPORT FOR PROJECT SCHOONER. Anspaugh, L. R.; Chertok, R. J.; Clegg, B. R.; (and others) (California Univ., Livermore. Lawrence Radiation Lab.). July 22, 1969. 75p. Dep. CFSTI.

Four abstracts were prepared covering effects on biological material by the Schooner detonation. The remaining six papers cover problems of ecology and atmospheric measurements as well as theoretical evaluations related to the Schooner event. (H.B.G.)

For abstracts of individual papers see: 653–655 and 692.

692 (UCRL-50718, pp 59-64) BIOLOGICAL AVAILABILITY TO PIGS OF RADIONUCLIDES IN SCHOONER DEBRIS. Chertok, Robert J.; Lake, Susanne; Serpa, Joseph W.; Dawson, John M.; Brunckhorst, Barry (California Univ., Livermore. Lawrence Radiation Lab.).

Pigs were stationed at various locations from ground zero of a 31 kiloton nuclear cratering explosion. For three days, they were allowed to breathe contaminated air and to eat food contaminated by fallout. After that time they were retrieved and various organs, as well as feces and urine, were analyzed for content of radionuclides. Tables of concentrations are presented. (H.B.G.)

693 METHODS FOR THE ARTIFICIAL CONTAMINATION OF VEGETABLES AND FRUIT WITH RADIONUCLIDES. Paulus, K. (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe, Ger.). Landwirt. Forsch., 20: 293-301(1967). (In German).

Artificial contamination of plants with ^{90}Sr and ^{137}Cs by spraying, injection, and by way of the roots was studied. Within two to three months after spraying potato plants, the leaves, stems, and potatoes contained 49.5, 12.2, and 2.5% of the ^{90}Sr, and 40.5, 5.2, and 20% of the ^{137}Cs sprayed. When potatoes were dipped in solutions of ^{90}Sr or ^{137}Cs, the uptake was almost proportional to the surface exposed to the solution, and decreased as the dipping time was increased. Following injection of the radioisotopes into carrots, ^{137}Cs was transferred into the roots considerably faster than ^{90}Sr. The results of contamination of carrots by dipping was similar to those found with potatoes. Following spray contamination of lettuce, most of the ^{137}Cs was resorbed rapidly, but 1/3 of the ^{90}Sr remained and could be rinsed away. After dipping, ^{137}Cs was easily washed off of leeks and spinach, but ^{90}Sr was relatively firmly held. The various methods of contamination were compared for various other fruits and vegetables, such as radishes, parsnips, celery, wheat, rye, barley, beans, peas, berries, apricots, plums, apples, pears, and citrus fruits. The relative advantages and disadvantages of the contamination procedure were discussed and suitable methods were suggested. (BBB)

694 TESTING THE EASE OF DECONTAMINATION OF COATINGS. Schmitt, B. F. (Bundesanstalt fuer Materialpruefung, Berlin). Kerntechnick, 11: 397-402(July 1969). (In German and English).

A number of different surface protection coatings were investigated by a standardized procedure with respect to the ease of decontamination of ^{45}Ca, ^{60}Co, ^{35}S (sulfate), ^{35}S (thiourea), ^{131}I, and ^{147}Pm (luminescent powder). The decontamination factors obtained are reproducible but have a scatter of 60 to 73%. It was found that the findings relating to the ease of decontamination of a given nuclide or of a given mixture of nuclides (solution of fission products) provide no information on how well other nuclides can be decontaminated. Surfaces contaminated with chemically reactive radioactive solutions cannot be decontaminated with nondamaging decontamination media. (auth)

695 EFFICIENCY OF LOW LEVEL DTPA THERAPY IN REMOVING PLUTONIUM FROM MICE. Smith, H.; Chapman, I. V.; Marlow, C. G. (United Kingdom Atomic Energy Authority, Chapelcross, Scotland). Nature (London), 222: 676(May 17, 1969).

Studies are described on the therapeutic use of diethylenetriamine pentaacetic acid (DTPA) for removing Pu from animals. It has been the normal practice in humans to give a series of 1g/kg body weight injections of DTPA in the treatment of Pu contamination; it is considered that this dosage may be considerably reduced, in most cases of accidental contamination, thus minimizing risk of side effects from DTPA. Mice and rats were given injections of small amounts of ^{239}Pu, equivalent to those commonly occurring in human accidents, and the effectiveness of removal by small doses of DTPA compared with that employing large doses. A technique was developed for the use of small amounts of ^{237}Pu as a metabolic marker for the ^{239}Pu. The Pu injection dose contained 9×10^{-3} μg/kg body weight of ^{239}Pu(IV) and 2.7×10^{-5} μg/kg ^{237}Pu(IV). The DTPA was given intraperitoneally at various times after the Pu injection, and excreta were assayed for Pu by means of the 100 keV X-rays from ^{237}Pu. It was found, in general, that the lowest DTPA dose level was as effective as the highest dose. The lowest level was equivalent to 0.2 g/kg in humans. The results appeared equally applicable to early and late treatments. (UK) (auth)

696 ^{137}Cs AND ^{90}Sr IN FLORIDA MILK: A FIVE-YEAR STUDY OF DISTRIBUTION AND LEVELS. Roessler, C. E. (Univ. of Florida, Gainesville); Williams, E. G.; Nettles, E. D. Health Phys., 16: 681-9(June 1969).

Unusually high ^{137}Cs levels and $^{137}Cs/^{90}Sr$ ratios in milk collected at the Tampa, Florida, station of the U. S. Public Health Service's Pasteurized Milk Network prompted a statewide study of radionuclide levels in Florida milk. Raw milk was collected monthly since 1963 from individual farms throughout the State and composited for analysis on the basis of six regions. Levels of radionuclides in the Tampa milkshed were found to be indicative of average concentrations in milk from much of Florida. There was a statistically significant difference between average levels of ^{137}Cs and ^{90}Sr in milk from the northwestern part of the State and those in the balance of the State. Furthermore, the data suggested a gradual transition from lowest ^{137}Cs and highest ^{90}Sr levels in the northwestern part of the State to higher levels of ^{137}Cs and lower levels of ^{90}Sr in the "peninsular" portion of the State, with the highest ^{137}Cs levels occurring in the central part of the State. The levels and geographical pattern of ^{90}Sr were consistent with the current understanding of the geographic distribution of radioactive fallout deposition in the country. However, the contrasting levels and distribution of ^{137}Cs suggest that some unusual mechanism is responsible for concentrating this latter nuclide in the local environment in a large portion of Florida. (auth) (UK)

697 FALLOUT RADIOACTIVITY IN KOREAN FOODSTUFFS. III. LEVELS OF ^{137}Cs IN KOREAN FOODSTUFFS. Yang, Kyung Rin (Atomic Energy Research Inst., Seoul). J. Nucl. Sci. (Seoul), 9: 61-72(1969). (In Korean).

Levels of ^{137}Cs in Korean foodstuffs were measured. Cesium-137 in marine products was analyzed radiochemically for β activity and in terrestrial foodstuffs was determined by the photo peak counting method. The amount of potassium in the same samples was also determined. (auth)

698 FALLOUT RADIOACTIVITY IN KOREAN FOODSTUFFS. II. LEVELS OF ^{90}Sr IN KOREAN FOODSTUFFS. Yang, Kyung Rin (Atomic Energy Research Inst., Seoul). J. Nucl. Sci. (Seoul), 9: 47-59(1969). (In Korean).

Levels of ^{90}Sr in Korean foodstuffs were measured. The samples involved about 20 kinds of terrestrial foodstuffs collected during 1964 and 1965 that were grown in farms near Seoul and about 50 kinds of marine products that were taken during 1968 inshore in Korea. Strontium-90 was analyzed radiochemically and the amount of stable calcium in the same samples was also determined. From the result, it is seen that the fallout deposition on the ground in 1965 was much decreased from that in 1964 and leafy vegetables were more contaminated by ^{90}Sr than cereals and root vegetables. Levels of ^{90}Sr in marine products varied with no rule but seaweeds show rather higher contamination than shell fishes and sea fishes. The levels of ^{90}Sr in all samples were below the maximum permissible levels recommended by ICRP. (auth)

699 FALLOUT RADIOACTIVITY IN KOREAN FOODSTUFFS. I. GROSS BETA ACTIVITY IN KOREAN MARINE PRODUCTS. Yang, Kyung Rin (Atomic Energy Research Inst., Seoul). J. Nucl. Sci. (Seoul), 9: 35-46(1969). (In Korean).

Beta activity in marine products was measured. About 50 kinds of samples were collected during 1968 by the Office of Marine Affairs, Pusan, and most of them were taken inshore in Korea. Radioactivity in the ashes of the samples was counted in a low background beta counter that had 0.63 cpm of background counts. The radioactive contamination levels were higher in order of seaweeds, shell fishes and sea fishes, but no clear differences were found by location. Radioactive contamination levels of the samples show no problems in respect to the health hazard of human population by radiation. (auth)

700 RADIATION ACCIDENT INVOLVING BODY CONTAMINATION AND INHALED GASEOUS RADIOIODINE-131. Lee, Hyun Duk (Atomic Energy Research Inst., Seoul). J. Nucl. Sci. (Seoul), 9: 9-13(1969). (In Korean).

Radiation accidents involving radioactive contaminations occurred frequently since research and development of the Atomic Energy were started in Korea. One of the biggest accidents occurred due to leakage of gaseous ^{131}I from the processing unit in the radiochemical laboratory. The accident was treated by taking definitive action to protect the workers from exposure to radiation and to keep the spread of radioactive contamination as small as possible. A victim's excrements and his thyroid were examined and the result of calculation of accumulated radioactivity in the thyroid gland was 0.36 μCi. This value is 2.4 times higher than the critical organ content given by the MPC for the occupational workers. (auth)

701 EXPERIENCE WITH PURITY TESTS OF $^{113}Sn-^{113m}In$ GENERATORS. Colombetti, Lelio G. (Veterans Administration Hospital, Palo Alto, Calif.); Barrall, Raymond C.; Finston, Roland A. Int. J. Appl. Radiat. Isotop., 20: 717-24(Oct. 1969).

The eluate from radioisotope generators of ^{113m}In with a hydrous ZrO_2 or SiO_2 bed were tested for radionuclidic and chemical purity. The radioactive impurities were measured by gamma-ray spectrometric analysis using NaI(Tl) scintillators and Ge(Li) solid state detectors. Calculations showed ^{113}Sn to be the principal source of extraneous patient radiation dose. Because of its long half-life, this radionuclidic impurity may deliver a significant dose in addition to that from ^{113m}In. The influence of eluant volume on ^{113}Sn breakthrough was also determined. Chemical spot tests and spectrographic analysis were used in searching for stable impurities. The principal impurities identified were: aluminum, cadmium, calcium, copper, magnesium, nickel, silicon, zinc, and zirconium. The potential risk to the patient from impurities was quantified and evaluated. (auth)

702 ^{14}C IN THE BIOSPHERE AND HUMANS. Harkness, D. D.; Walton, A. (Univ. of Glasgow). Nature (London), 223: 1216-18(Sept. 20, 1969).

Many methods have been used to calculate the quantity of ^{14}C reaching man from the environment as a result of nuclear fission and fusion devices. Comparisons with measurements of ^{14}C in blood samples indicate that these calculations could be wrong, particularly for the first ten years or so after a sharp increase in environmental radiation. (auth)

703 PUBLIC HEALTH ASPECTS OF IONIZING RADIATIONS. Lewis, M. M. J. Roy. Inst. Public Health, 31: 106-13 (July-Dec. 1968).

A review is presented of the biological effects of ionizing radiations, including somatic and genetic effects, the acute radiation syndrome, and hazards to public health introduced by military and peaceful uses of atomic energy. The Windscale accident is cited as an example of hazards from power reactors. A great deal was learned from this accident regarding the release of fission products, the behavior of those products in the atmosphere, the manner of their deposition and of their entry into food chains. In this respect it could be considered a profitable experience because the actual cost of the accident in real, as opposed to material, values appears to have been small. Public health interest in the radiations from nuclear weapons, concerned mainly with contamination of the environment by fission products, is discussed. It is concluded that protection against ionizing radiations was developed to a far greater extent than against other hazards to the public health. Acute high-level exposure has resulted in some cases of severe damage and death, but such incidents were rare and the chances of their occurrence in the future are even rarer. Exposure to low doses is generally regarded as resulting in hereditary effects, and in delayed somatic effects such as leukemia. However there appears to be no grounds for concern about either the immediate or the long-term effects of exposure within the present permissible limits. (BBB)

Dosimetry and Monitoring

Refer also to abstracts 87, 484, 544, 580, 652, 1684, and 1707.

704 (AD-689119) RADIATION MEASUREMENTS AT SUPERSONIC TRANSPORT ALTITUDE WITH BALLOON-BORNE NUCLEAR EMULSIONS. Schaefer, Hermann J. (Naval Aerospace Medical Inst., Pensacola, Fla.). May 2, 1969. 20p. (NAMI-1068). CFSTI.

The results of measurements with balloon-borne nuclear emulsion packs at supersonic transport altitude are presented. The experimental design was such that the track population in the emulsion reflected directly the flux of low energy protons in the tissue equivalent material surrounding the emulsion on all sides. The radiation packs accompanied a main payload consisting of neutron spectrometer equipment. Packs were flown on a number of flights, each of them sampling a different altitude. No solar activity was recorded during the entire flight time; therefore, the data are representative of galactic radiation at solar maximum for a quiet Sun. (auth)

705 (COO-119-240, pp 7-85) INJECTION TABLES. (Utah Univ., Salt Lake City. Radiobiology Div.).

Injection tables were prepared for various radioisotopes. Doses were calculated for each beagle based on individual retention values. The dogs were divided into two groups. The first group represented toxicity animals that were maintained until sacrifice became a clinical necessity. The second group were test animals and were sacrificed as needed for special studies. (H.B.G.)

706 (JAERI-1180) CALCULATION OF SURVIVAL RATES AND EFFECTIVE INACTIVATION CROSS SECTIONS OF TARGETS FOR HEAVY CHARGED PARTICLES BASED ON MICRODOSE CONCEPT. Numakunai, Takao; Ohtani, Satoru; Kawai, Katsuo; Oda, Nobuo (Japan Atomic Energy Research Inst., Tokyo). Mar. 1969. 12p. Dep. CFSTI (U. S. Sales Only).

According to the microdose concept, survival rates and effective inactivation cross sections of the targets are studied for heavy charged particles of energies 4 to 12 MeV/amu and of charges 1 to 18. Calculation was performed using an IBM-7044 computer. The survival rates were calculated for one-, two-, and three-events models with different combinations of the following parameters: effective charges of ions, Z_{eff}, incident energies of ions, E_p, cut-off energies of δ-rays, η, target thicknesses, l. As an input quantity, Z (primary energy transfer per target) was used. The effective inactivation cross sections were derived from the survival rates for the one-event model. (auth)

707 (RLO-2047-5, App. E) EXPLORATORY STUDIES WITH THERMAL LUMINESCENT DOSIMETERS. (Washington Univ., Seattle. Lab. of Radiation Ecology). 4p.

Preliminary studies were performed to measure the activity of ^{40}K, ^{65}Zn, and ^{51}Cr in water by means of extruded lithium fluoride in wafer form. Thus far, reasonable values were obtained; however, the technique requires further improvement to make results more reliable. (H.B.G.)

708 RADIATION EXPOSURE IN RADIOGRAPHY OF THE GASTROINTESTINAL TRACT. Seyss, R. (Roentgenabteilung des Krankenhauses, Neunkirchen, Austria). Radiol. Aust., 17: 135-42(1967). (In German).

The effects of several physical factors on irradiation doses administered to more than 5000 patients during fluoroscopy of the gastrointestinal tract were studied. The irradiation dose increased with field size, but not linearly. Increased size or volume of the patient required larger irradiation exposures. Irradiation doses were decreased by using higher voltages, particularly when adequate contrast was required in Ba studies. Use of adequate filters decreased irradiation dose, particularly with supervoltage irradiation. Relations between exposure time and irradiation dose from supervoltage irradiation were discussed. The greatest irradiation doses were observed in fluoroscopy of the large intestine, where more detailed studies were frequently necessary. Double contrast procedures were most useful to reduce irradiation doses. The image amplifier and television monitor were very suitable for decreasing irradiation doses from gastrointestinal function fluoroscopy studies. 51 references were cited. (BBB)

709 NEUTRON DOSIMETRY IN THE IN VIVO MEASUREMENT OF INTRATHYROIDAL IODINE IN MAN BY ACTIVATION ANALYSIS. Boddy, K. (Scottish Research Reactor Centre, Glasgow); Dennis, J. A.; Lawson, R. C. Phys. Med. Biol., 14: 471-80(1969).

A collimated beam of neutrons from a reactor was used to irradiate the thyroid inducing ^{128}I which can be detected by external counting. Neutron dosimetry studies were carried out with the unmodified beam and also using a boron filter to absorb incident thermal neutrons. Five methods were used to provide dose estimates and the results were in reasonable agreement, giving for a clinical examination at 20 kW reactor power a mean dose-equivalent and standard error of 20.4 ± 1.1 rem for the filtered beam, and 24.1 ± 1.2 rem for the unmodified beam, due to neutrons at the thyroid. The concurrent γ-ray dose was 2.1 ± 0.2 rem. The dose to the eyes and gonads was less than 1% of the thyroid dose. (auth) (UK)

710 RADIOSENSITIVITY AND SPATIAL DISTRIBUTION OF DOSE. Reports Prepared by Two Task Groups of Committee 1 of the International Commission on Radiological Protection. I.C.R.P. Publication 14 (Radiation Protection). Oxford, Pergamon Press, 1969. 122p. 35s.

Reports are presented from the two Groups, set up in 1965, under the following main headings: Task Group 1. Spatial Distribution of Radiation Dose. Basic considerations; current recommendations on non-uniform exposure; scheme for non-uniform exposure based on risk considerations; range of linearity of dose response; non-uniformity of dose within organs and tissues; additivity. Task Group 2. Relative Radiosensitivities of Different Tissues. Expression of radiation damage (tumor induction, cataract, impaired fertility, damage to bone marrow and cellular defenses, defective growth and development, life-shortening and somatic effects, genetic damage); radiosensitivities of different organs and tissues in man; relative sensitivity to different kinds of biological damage by radiation and overall assessment of radiation damage; revision of currently recommended dose limits. (UK)

711 CALORIC METHOD FOR DETERMINATION OF A PART OF ABSORBED ENERGY OF SOFT X RADIATION THAT IS NOT DEGRADED INTO HEAT. Saebel, Manfred; Schmidt, Theodor (Univ., Erlangen, Ger.). Z. Naturforsch., 24b: 1338-40(Oct. 1969). (In German).

Most of the energy of ionizing radiation is absorbed by material in the form of heat; a small fraction may cause radiochemical reactions in suitable substances. To differentiate between the two types of absorption, a calorimetric method was developed that allows comparative measurements between lead in which all absorbed energy appears as heat, and several organic polymers in which radiochemical reactions are prone to occur. (H.B.G.)

712 METHOD FOR STANDARDIZING THE GAMMA-RAY EMITTED RADIATION SOURCES AND THE PORTABLE SURVEY METERS AT THE RESTRICTED AREA. Lim, Yong Kyu; Ro, Seung Gy; Lim, Woo Yung (Atomic Energy Research Inst., Seoul). J. Nucl. Sci. (Seoul), 9: 15-20(1969). (In Korean).

A method for standardizing γ radiation sources and portable survey meters at restricted areas, namely, the place surrounded with 30 cm thickness of concrete and 7.9 m × 5.8 m × 3.7 m(h) in its inner space dimension was presented. Scattering effect of ^{60}Co and ^{226}Ra γ rays went to minimum at 0.6 to 0.7 of radiation source-detector distance(D) over concrete floor-detector height(H), and also the effects due to self-absorption, air build-up, and geometrical factors were negligible at 60 to 70 cm in D and 100 cm in H while any scattering object is not close to the radiation source or the detector. It is considered, therefore, to be optimum standard-

izing condition of radiation sources and radiation detecting instruments in restricted areas. (auth)

713 DEPTH THERAPY WITH PENDULUM ELECTRON RADIATION. FIRST REPORT: BASIC STUDIES WITH STATIONARY FIELDS OF 43 MeV ELECTRONS. Rassow, Juergen (Ruhr Univ., Essen). Strahlentherapie, 138: 267-85(Sept. 1969). (In German).

Characteristical values of the water-equivalency of different materials used in phantoms and of the different human tissues were calculated. The exceptional good water-equivalency of the material used, a polysterene called Vestyron, was experimentally demonstrated. Dosimetry in a transversal plane and isodoses in other planes for electrons of 43 MeV were established to show the influence of the scatter foils and of the walls of the collimator. The same method was applied to show the utility of a universal collimator, allowing a continuous choice of field dimensions and for pendular therapy with an axis depth up to 25 cm. Through the use of nearly unscattered electron beams for pendular radiotherapy, an homogeneous dose distribution was obtained in a plane perpendicular to the pendular plane, a low dose outside the irradiated volume and ahead of the penetration of the electrons. (auth)

714 DISTRIBUTION OF TISSUE DOSES IN THE BODIES OF SMALL ANIMALS. Rasin, I. M.; Sarapul'tsev, I. A.; Shvedov, V. L. (Inst. of Biophysics, Moscow). Radiobiologiya, 8: 666-70 (1968). (In Russian).

A study was made of the distribution of the dose rates from ^{90}Sr in individual organs and tissues of the rat by the method of quantitative autoradiography. Maps of isodoses were constructed according to transverse cross-sections of the thoracic cavity and the stomach and one longitudinal section of the head. The dose rate can be determined at any point of the section with the aid of isodose maps. Calculation of the dose rate at any point of an analogous section of a rat subjected to chronic ^{90}Sr exposure may be calculated from the isodose map. (JPRS) (TSS)

715 EVALUATION OF FAST ELECTRONS FROM THE STANDPOINT OF RADIOTHERAPY. SECOND PART: BEHAVIOR OF FAST ELECTRONS HITTING SURFACES OF VARIOUS FORMS. Vogel, Karl-Heinz (Medizinische Strahleninstitut, Tuebingen, Ger.). Strahlentherapie, 138: 286-92(Sept. 1969). (In German).

Various shapes of surface and tissue structure were studied with respect to dose distribution for electron beams. The most important finding was a twofold increase in dose at the bottom of cylindrical cavities in tissues. Therefore, caution should be exercised before using electron therapy in regions where such cavities exist. (H.B.G.)

716 CONTRIBUTION TO FILM DOSIMETRY OF HIGH-ENERGY RADIATION. PART I. SELECTION OF BEST FILM DEVELOPERS BY INVESTIGATING ^{60}Co GAMMA RADIATION WITH RESPECT TO GRADATION AND ACCURACY. Rassow, Juergen; Erdmann, Ute; Strueter, Horst-Dieter (Ruhr Univ., Essen). Strahlentherapie, 138: 149-56(Aug. 1969). (In German).

By eliminating all possibilities of systematic errors, the suitability for practical film dosimetry of 64 combinations between 11 films and six developers was studied. In spite of a homogeneous exposure to cobalt γ rays and developing in optimal conditions, variations in the blackening occurred on the same film. This must be considered as a small but inevitable inherent error. For radiotherapy, films that are relatively insensitive should be chosen. The results concerning the form of the gradation curve and the curve of merit, and also the dose range with relative accuracy of 5%, 2.5%, or 1.5%, are grouped in a table. Furthermore the graduation and the merit curve is shown for 30 film-developer combinations. (auth)

717 RADIATION DOSE TO THE BONE IN RADIOTHERAPY OF UTERINE CARCINOMA. Czalkowski, Peter-Michael (Univ., Saarlandes, Ger.). Strahlentherapie, 138: 337-45 (Sept. 1969). (In German).

The dose absorbed by bone tissue at the usual treatment techniques for pelvic tumors was calculated in order to study the problem of radiation necrosis of the neck of the femur. Comparative measurements were made in phantoms by thermoluminescent dosimeters. Particular attention was given to the radiation scattered outside the geometrical cone in roentgen rays. This scattered radiation is readily absorbed in bone because of its low energy. A method is described to measure the effective quantic energy. According to the calculations and the measurements, the dose in the neck of the femur is about 3000 rd for the usual irradiation techniques. They show also a great superiority of telecobalt radiation over conventional roentgentherapy. (auth)

718 MEASUREMENT OF ISODOSES FOR ^{60}Co EYE APPLICATOR (ACCORDING TO STALLARD). I. ISODOSES OF THE APPLICATORS CKA 1-4. Magnus, L.; Goebbeler, T.; Rassow, J.; Stroetges, M. W. (Rhur Univ., Essen). Radiol. Clin. Biol., 38: 213-27(1969). (In German).

Isodose measurements in a paraffin phantom were made with the ^{60}Co applicators CKA 1-4 (Stallard) and represented in graph form. In the applicators CKA 1-2 the depth dose factors given by the manufacturers are 20% too low, whereas the dose factors for CKA 3-4 were confirmed. There was complete agreement with the photometric depth dose measurements of L. Magnus (1967); their values for the applicators CKA 1-2 must however be increased by 20%, as they were based on the manufacturer's figures. Regarding the problem of radiation protection, the operator should, in view of the high exposure to the fingers, operate at the most once a week with ^{60}Co applicators. Great emphasis should be put on instrumental operating. The present measurements have put the well proven method of radiotherapeutic treatment of malignant eye tumors on an exact base. (auth)

719 RADIATION EXPOSURE OF PERSONNEL USING IMAGE AMPLIFIERS FOR CONTRAST EXAMINATIONS OF THE GASTROINTESTINAL TRACT. Schulte-Brinkmann, Wolfgang; Magdsick, Gero (Univ., Duesseldorf). Strahlentherapie, 138: 186-96(Aug. 1969). (In German).

Radiation scattered during radiological examination of the gastrointestinal tract with contrast media was measured. After measurements on phantoms to determine the dose scattered around the apparatus, measurements were done during 70 gastrointestinal tract examinations and 30 barium-enemas of the colon. The mean dose received by the operator during the examination of the stomach was 92 mR at the thoracal region, 150 mR at the hypogastrium, and 972 mR at the level of the talocrural joint. For the barium-enemas the doses were respectively 106 mR, 185 mR, and 1475 mR. Assistants received distinctly higher doses. The radiation exposure lessens with shortening of the examination time and with the operators experience. With more than 1000 examinations in a year, the radiation dose received is less than 2% of the permissible annual dose. The influence of the light amplification and television technique on the exposure dose is probably small. (auth)

720 INADEQUACY OF AN EXTERNAL STANDARD IN CORRECTING FOR QUENCHING IN LIQUID SCINTILLATION COUNTING OF TRITIATED WATER IN BIOLOGICAL MATERIAL. Springell, P. H. Int. J. Appl. Radiat. Isotop., 20: 743-6(Oct. 1969).

The value of using an external γ source as a means of quench correction in liquid scintillation counting of tritium in plasma, urine and rumen liquor are compared with results obtained by distillation and by internal standardization. The scintillation mixture throughout the investigation consisted of 120 g naphthalene, 4 g PPO and 50 mg POPOP made up to 1.1 with 1,4-dioxane, before addition of 100 ml triton X-100. The results indicate that the γ source had the highest count in the most highly quenched systems, and vice versa. It is evident that use of an external standard is of no advantage when dealing with biological material collected at one time and derived from the same source. This is even more evident in samples collected from different animals (plasma), or from the same animal at different times (urine and rumen liquor). By contrast, the results indicate that internal standardization gives results which are most closely comparable to those obtained following distillation. (UK)

721 ON THE CALCULATION OF DOSES OF JUSTIFIED RISK DURING LONG-TERM SPACE FLIGHTS. Kovalev, E. E.; Popov, V. I.; Sakovich, V. A. Kosm. Biol. Med., 3: No. 4, 29-32(July-Aug. 1969). (In Russian).

A procedure is presented for calculating doses of justified risk during chronic irradiation, depending on the time of the exposure. Processes of radiation repair in a living organism are described by means of a Blair model. Using the above procedure and adopted doses of justified risk for short duration flights, adequate levels for long-duration missions are assayed. (auth)

722 HIGH-ENERGY ELECTRON DOSE PERTURBATIONS IN REGIONS OF TISSUE HETEROGENEITY. Boone, Max Lee Morrison. Houston, Tex., Univ. of Texas, 1969. 170p. Thesis.

In high-energy electron radiotherapy, the biologically significant quantity is the locally absorbed dose within the irradiated tissues. This quantity has usually been approximated by indirect measurements, most often in homogeneous materials of unit density such as water. As a further refinement of physical studies, the heterogeneity in density and composition of body tissues has been simulated by use of various phantom materials. These studies have demonstrated marked perturbations of dose distributions compared with those measured in homogeneous media. A new approach to the study of tissue heterogeneity effects on

high-energy electron absorption is presented, namely, the direct measurement of radiation tissue doses in vivo. More than 500 in vivo dose determinations were performed, utilizing lithium fluoride thermoluminescence dosimeters placed within the tissues of interest. As a result of these studies, mathematical models were derived which make possible the prediction of dosage distributions in regions of tissue heterogeneity. The results of in vivo dosimetry in man in regions shielded by the ramus of the mandible have shown good correlation with a mathematical model based on the ratio of electron densities (electrons/cm^3) of compact bone to muscle tissue. This model proposes that compact bone presents 1.65 times as many electrons/cm^2 to the beam as muscle tissue, and attenuates the dose accordingly. In contrast, the human sternum produces on the average the same attenuation of dose as unit density tissue. The mean density of the sternum was found to be 1.15 ± 0.05 gm/cm^3, but its electron density is nearly identical with that of muscle tissue. Results of dosimetry with the human sternum correlated well with a mathematical model for the effect of spongy bone on dose distribution. Surgical implantation of dosimeters at the chest wall-lung interface provided evidence of diminished backscattering of electrons from the less-dense lung tissue, and established the extent of attenuation of dose by the ribs. Intrabronchial and esophageal dosimeters were used to study alterations in the absorption of high-energy electrons in lung tissue. The mean density of dog lung was determined to be 0.35 ± 0.04 gm/cm^3 at mid-inspiration. This lower density leads to a decrease in scattering of electrons, and the dose in the superficial portion of the lung is lower than at the same depth in water. Only at greater depth in lung tissue (about 1.5 cm from the pleural surface) is the decrease in dose, due to reduced scattering, offset by the increase in dose, due to the increased range of the electrons in the direction of incidence. At greater depths, absorbed doses in lung are substantially greater than at corresponding depth in water. A model for the effect of lung tissue on absorbed dose was derived by definition of coefficients of equivalent thickness (C.E.T.) which are a function of electron beam energy and depth in lung tissue. It was proposed that at increasing depths, the C.E.T. should approach a value numerically equivalent to the lung density. Theoretical and experimental support for this hypothesis was advanced. (auth)

Radiation Protection

Refer also to abstracts 703, 736, 779, 878, and 1468.

723 THE JUDICIOUS USE OF DIAGNOSTIC RADIATION IN THE HEALING ARTS. Cole, William S. (Bureau of Radiological Health, Rockville, Md.). Amer. J. Public Health, 59: 1199-1203 (July 1969).

The extent of population exposure to diagnostic radiation and the means to reduce it are reviewed. Diagnostic radiology has a strong influence on the practice of medicine; at present, 50% of the diagnoses in clinical medicine are either made or confirmed by radiological procedures. The volume of diagnostic radiological procedures is large and is increasing at a rate >7% yr. Fluoroscopy is one of the most widespread diagnostic procedures used by physicians, and without image intensification the exposure of the patient may be 100 times that required for a more informative radiograph. Fluoroscopic equipment with image intensification should be used instead of the older screen system. A recent national survey indicated the prevalence of radiological procedures used in pregnant women, and the necessity for careful evaluation of the possible benefit to be obtained. Volunteer health agencies with mass x-ray survey programs should be aware of the radiation exposure involved in the photofluorographic chest examination and the limited information obtainable from this procedure. Routine x-ray procedures should be abandoned. (BBB)

724 DENTAL X RAYS: SHOULD ONLY BE USED WHEN IMPORTANT TO PROPER DIAGNOSIS. J. Calif. State Dent. Ass., 44: 43(Feb. 1968).

Eleven recommendations are made whereby dentists can reduce radiation exposure to themselves and their patients, as follows: Radiographic examinations should not be made periodically or routinely. Use the fastest speed film available (USASI Speed Group rating of D or faster). Use only a collimated x-ray machine so that the beam is not more than 2.75 in. in dia. The x-ray machine should contain filtration of 2 mm of Al equivalent if operating at less than 70 KVp and 2.5 mm if operating at 70 KVp or above. Use shielded open-end cones to reduce scatter radiation. Use leaded aprons on children and all patients of reproductive age to prevent irradiation of the gonads. Use film holders, bite tabs, or other means to position film during exposure; never hold a film in place for a patient. Have periodic radiation protection surveys made. Properly expose the x-ray film; overexposure with underdevelopment subjects the patient and office personnel to unnecessary irradiation. Follow manufacturer's instruction for processing x-ray film. Continue education in the radiologic health practices. (BBB)

725 RADIATION PROTECTION WHEN USING DENSITOMETERS. Jaeckel, P. Deut. Textiltech., 18: 573-7(Sept. 1968). (In German).

Densitometers consist of electronic units embodying sources of ionizing radiation. Factors having a bearing on radiation protection are discussed, also acceptable radiation doses, workplace organization, and metering instruments (Curiemeter, sensor). Production is not affected by the necessary protective measures. (auth)

726 OCCUPATIONAL SAFETY AND HEALTH IN THE BASIC METAL INDUSTRIES. Ziobinskii, B. M. Moscow, Izdatel'stvo Metallurgija, 1968. 459p. 1.07 rouble. (In Russian).

The following topics are presented and discussed: an outline of Soviet occupational safety and health legislation; analysis of working conditions; organization of production and work; construction and arrangement of buildings (air conditioning, ventilation and heating, lighting, etc.); technical preventive measures; personal protective equipment; organization of a works safety service; fire prevention; protection against thermal radiation; protection against noxious (toxic) substances; electrical safety; protection against radiofrequency radiations; protection against ionizing radiations; protection against noise and vibration, including ultrasound; guarding of machinery; prevention of explosions; and protection against pollution of the atmosphere and water. (Occup. Safety and Health Abstr.)

727 PROTECTION AGAINST RADON PROGENY INHALATION USING FILTER TYPE RESPIRATORS. Martz, Dowell E.; Schiager, Keigh J. (Colorado State Univ., Fort Collins). Contract AT(11-1)-1500. Health Phys., 17: 219-28(Aug. 1969).

The efficiencies of several respiratory protective devices in removing the airborne radon daughter activity found in underground uranium mines were determined under standardized test conditions. The protection afforded to working uranium miners by simple filter respirators was estimated by comparison in vivo counting of the internally deposited RaC activity present in the respiratory systems of miners at the end of the working shift. The mean protection efficiency obtained was $85.2 \pm 13.8\%$, based on in vivo counts of 21 miners. The problem of providing adequate respiratory protection for underground uranium miners is discussed and a suggested list of criteria for respirator design is given. (auth) (UK)

728 THE EFFECT OF PROTECTIVE APRONS IN DENTAL ROENTGENOGRAPHY. Bean, L. R. Jr.; Devore, Waldo D. (Univ. of Kentucky, Lexington). Oral Surg., Oral Med., Oral Pathol., 28: 505-8(Oct. 1969).

Measurements were made of gonadal radiation while full-mouth dental roentgenograms were being taken of 60 adult male subjects. Radiation to the gonads was greater when the short pointed cone was used than when the long open-ended cone was used. Lead protective aprons significantly reduced the radiation to this area, and little difference was seen between the ability of the bib and lap aprons to provide gonadal protection. (auth)

729 DENTAL RADIOGRAPHY: RADIATION PROTECTION Wuehrmann, Arthur H. (Univ. of Alabama, Birmingham). J. Amer. Dent. Ass., 77: 200(Aug. 1968).

Deficiencies in teaching in dental radiology that result in inadequate training of dentists in radioprotective practices are briefly discussed. Comments are made on a recent survey of 16 dental schools revealing that a student receives an average of only 72 clock hours of instruction in the field of radiology. It is pointed out that 72 hr of instruction is insufficient. A recent undergraduate dental school curriculum workshop in dental radiology recommended at least 130 hr and recognized this as a minimum time that should be allocated to the subject. Dental hygienists receive 116 hr of instruction in radiology and dental assistants' training includes a total of 105 hr of instruction. It is concluded that organized dentistry and educational institutions have a responsibility toward improving the understanding of the graduating dentist as it relates to dental radiology. (BBB)

730 STRAY RADIATION. Crandell, Clifton E. (Univ. of North Carolina, Chapel Hill). Tic (Albany, N. Y.), 27: 5-6; 15-16(Jan. 1968).

Leakage radiation and secondary radiation as they occur in dental radiography are explained and means of minimizing both are outlined. Stray radiation may be minimized by reducing the total amount of radiation that is used. How this may be accomplished is described. The use of higher kilovoltage increases penetration,

permits shorter exposures, increases the percentage of meaningful radiation that reaches the film, and reduces the amount of stray radiation. The use of faster films requires less radiation at a reasonable sacrifice in film quality. This is the simplest and most effective way to minimize stray radiation. Reducing the field size of the beam of radiation (by inserting a lead diaphragm) will decrease stray radiation. The amount of tissue that is exposed to radiation is reduced, that in turn reduces the area from which secondary radiation can emanate. Use of an open-ended cone rather than a plastic pointed cone decreases stray radiation. Stray radiation may also be minimized by changing office arrangements and procedures. Protective barriers, such as sheet lead, lead bonded to plywood, lead core doors, and lead shields, are ideal ways to absorb substantial portions of primary or secondary radiation in dental offices. (BBB)

731 PROBLEMS OF RADIATION SAFETY IN MANNED FLIGHTS OF SOYUZ SPACECRAFTS. Vorob'ev, E. I.; Grigor'ev, Yu. G.; Efimov, V. I.; (and others). Kosm. Biol. Med., 3: No. 4, 24-9(July-Aug. 1969). (In Russian).

Basic principles of maintaining radiation safety of manned Soyuz-3, 4, and 5 flights are presented. During the entire missions radiation levels within the space cabin and along the spacecraft route remained within permissible limits, as indicated by onboard measurements and observations of geophysical effects. Analysis of the finding allows a conclusion to be made that radiation safety was maintained during Soyuz-3, 4, and 5 manned flights. (auth)

Safety Procedures

Refer also to abstract 727.

732 SOME ASPECTS OF LASER SAFETY. Harris, K. D. (Laser Associated Ltd., Slough, Eng.). Non-Ioniz. Radiat, 1: 84-7(Sept. 1969).

Considerable study has been made over the past few years of the conditions under which damage can be sustained by living tissue due to laser light. This has led to limits of power density which should not be exceeded without caution. However, many applications have to be carried on where it is not possible to exclude all possibility of hazard. In such cases it is necessary to assess the probability of the hazard and to decide whether the event is sufficiently improbable to be acceptable or not. Some of the factors useful in making this type of assessment are discussed. (auth) (UK)

Civil Defense

Refer also to abstracts 410 and 703.

733 THE ACTION FACTORS OF ATOMIC WEAPON DETONATION ON THE HUMAN BODY AND THE MEASURES OF MEDICAL AID. Koenig, W. (Deutsche Akademie fuer Aerztliche Fortbildung, Berlin). Z. Aerztl. Fortbild., 61: 453-7 (May 1, 1967). (In German).

Effects of nuclear weapons are briefly reviewed. The survey is intended for a course for physicians, dentists, and pharmacists. Protective measures are discussed in terms of health physics and medicine. (H.B.G.)

Legal Aspects

Refer also to abstracts 453, 688, and 726.

734 NEW ASPECTS IN THE REGULATION OF IONIZING RADIATIONS. Dien, B. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), Suppl., No. 76, 11-16(Mar.-Apr. 1969). (In French).

The regulations of ionizing radiations imposed by Euratom treaties are summarized with the purpose of giving users practical hints on their application. A brief review is given of the regulation of classified installation and of transporters. A more detailed examination is made of the regulations concerning workers. (J.S.R.)

735 NUCLEAR RISK AND CIVIL RESPONSIBILITY. de los Santos Lasurtegui, Alfonso (Junta de Energia Nuclear, Madrid). Energ. Nucl. (Madrid), 13: 159-72(Mar.-Apr. 1969). (In Spanish).

Theories on which civil responsibility is based are summarized. The theory of the objective responsibility in doctrine, in national legislation, and in international agreements is then defined. Derivative civil responsibility of a nuclear accident is considered under the aspects of limit of applicability of the law, responsible person, amount of indemnification in the case of accident, and establishment of the legal place at which legal proceedings can be initiated. (J.S.R.)

736 RADIATION PROTECTION. Med. Res. Eng., 8: 46(May-June 1969).

New federal legislation in the field of radioprotection is briefly reviewed, and especially the Act known as the "Radiation Control for Health and Safety Act of 1968." In this Act, Congress declared that the public health and safety must be protected from the dangers of electronic product radiation. It, therefore, provides for the establishment by the Secretary of HEW of an electronic product radiation control program that shall include the development and administration of performance standards to control the emission of electronic product radiation from electronic products. Electronic products that may emit radiation include: television sets, neutron generators, particle accelerators, electron microscopes, x-ray machines, and high voltage cathode-ray-tubes; other irradiators that may emit uv, visible, ir, microwave, radio, and low-frequency radiation such as uv sources, photochemical devices, welding equipment, fluorescence equipment, as well as ir devices such as driers, ovens, and heaters, ir lamps, ir alarm systems, radiofrequency sources, such as those used in diathermy, cauterizers, dessicators, signal generators, and other electro-medical equipment, extending into the microwave region. Other equipment to be subject to surveillance are radar devices, microwave ovens, and remote control garage door openers. A wide variety of lab equipment is also likely to be brought under the control and surveillance including, for example, lasers, masers, ultrasonic oscillators and cleaners, cell and tissue disintegrators, and ranging-and-detection equipment. The powers of the Secretary with regard to this law, interrelations with other agencies such as the AEC, and performance standards for electronic products are also considered. (BBB)

737 IONIZING RADIATIONS. FUNDAMENTALS, RADIATION PROTECTION RULES, AND USE. Koetter, J. (Niedersaechsische Landesverwaltungsamte, Hanover). Arbeitsmed. - Sozialmed. - Arbeitshyg., 4: 2-7(Jan. 1969). (In German).

Procedures and materials used for radiation protection were reviewed. The types and amounts of shielding to be used for radioisotope containers, and the relative effects of source distance and time of exposure were indicated briefly. It was emphasized that the major radiation protection measures that an individual worker should take include wearing of protective clothing that should be readily washable and be worn only in the area where radioactive materials were used; adequate ventilation with an absolute filter to ensure that the atmospheric concentration of radioisotopic material did not exceed permissible limits; and avoidance of eating or drinking foods, smoking, or use of cosmetics in areas where radioisotopes were used. Frequent (daily) monitoring of areas, where radioisotopes were used was recommended, and permissible surface area concentration equivalents for radioactive decay of α and β particle emitters were presented. The permissible upper limit for hand contamination with radioisotopes was estimated to be 20% as much as the permissible working area surface contamination limit. (BBB)

738 GENERAL RULES OF SAFETY FOR USE OF THE OPERATORS OF RADIOGRAPHIC EQUIPMENT. Dentoscope, 4: 17-26(Autumn 1968). (In French).

The general safety rules for the use of radiographic equipment are summarized for the operator of such equipment. The rules written in very basic terms so as to be readily understood, are concerned with the dangers of radiation, individual dosimetry, direct and scattered radiation, radiation protection, and medical examinations for equipment operators. (J.S.R.)

739 WAIVING DEFENSES: A NEW APPROACH TO PROTECTING THE PUBLIC AGAINST FINANCIAL LOSS FROM USE OF ATOMIC ENERGY. Trosten, Leonard M. (Columbia Univ., New York); England, William T. Fed. Bar J., 27: No. 1, 27-54(Winter 1967).

The recent amendment to the Price–Anderson Act represents a compromise. Like other compromises, this amendment leaves a number of questions unresolved. Nevertheless, enactment of a law providing, in effect, for strict liability on such a broad scale is a significant achievement, given the differing and strongly held points of view on the subject. Of significance also are certain other features of the amendment, including its provision for a minimum period for assertion of claims and mechanism for consolidation of suits in a single Federal court. The Price–Anderson Act, like the atom, is no panacea but it does afford very substantial protection to the public from the potential financial hazards flowing from development of this energy source. Should the Act's provisions ever be called into play, the writers believe the 1966 amendment will have markedly improved that protection. (auth)

Medicine

Protective Substances

Refer also to abstracts 626, 861, 869, and 926.

740 USE OF A CHEMILUMINESCENT METHOD TO INVESTIGATE THE PROTECTIVE ACTION MECHANISM OF CERTAIN SUBSTANCES AND THEIR MIXTURES. Burdin, K. S.; Parkhomenko, I. M.; Petrusevich, Yu. M.; Shestakova, S. V. Tr. Mosk. Obshchest. Ispyt. Prir., Otd. Biol., 16: 19-21(1966). (In Russian).

Studies were made on the effects of radioprotectors on recombined luminescence of radicals appearing during the electrochemical oxidation of tyrosine in a 0.11 M solution of Na_2SO_4. Intensity of luminescence was determined with a photomultiplier. The results showed that AET, medinal, veronal, and evipal quenched chemiluminescence of radicals formed during tyrosine electrolysis; these apparently act as antioxidants. On the other hand, gramicidin and propyl gallate increased chemiluminescence probably by increasing the number of radical recombinations. In testing the radioprotector effectiveness of the preparations on γ irradiated cells, the barbituric acid derivatives (veronal and evipal) offered little protection. Pyridine increased the survival of SOT's cells irradiated with a 900 R dose from 19.5 to 40%. No potentiated effect was produced by combining AET with veronal or AET with evipal. Survival of cells was markedly increased by combining AET with propyl gallate, AET with gramicidin, AET with vinylpyrrolidone, anoxia with vinylpyrrolidone and anoxia with pyridine. However, a potentiated effect was not produced by combining gramicidin with vinylpyrrolidone. It was concluded that a potentiated radioprotective effect is produced by combining preparations with different action mechanisms in relation to radicals. (ATD)

741 TERMINALLY SUBSTITUTED S-2-(ω-AMINOALKYLAMINO)ETHYL DIHYDROGEN PHOSPHOROTHIOATES AND RELATED COMPOUNDS AS POTENTIAL ANTIRADIATION AGENTS. Piper, James R.; Stringfellow, Carl R. Jr.; Johnston, Thomas P. (Southern Research Inst., Birmingham, Ala.). J. Med. Chem., 12: 244-53(Mar. 1969).

The high radioprotective activity in mice by S-2-(ω-aminoalkylamino)ethyl dihydrogen phosphorothioates prompted a study of the effect of alkyl and aryl substitution on the terminal amino group in these compounds. The approach involved protection of amino groups by prior tosylation and concurrent detosylation and hydrogen bromide cleavage of 3-substituted 2-oxazolidinones. Methods are stated for synthesis of terminal N-alkyl and N-aryl derivatives of S-2-(ω-aminoalkylamino)ethyl dihydrogen phosphorothioates and related compounds for evaluation as antiradiation agents. The generally preferred synthesis involved the concurrent detosylation and ring cleavage of 3-substituted 2-oxazolidinone intermediates containing a tosylated aminoalkyl side chain. Acetoxy group cleavage in conjunction with detosylation was also useful in the synthesis of N-alkyl derivatives. The last-step phosphorothioate displacements were generally successful in the N-alkyl series, but only thiosulfate displacements were successful in the N-aryl series. Among the congeners prepared, S-2-(3-ethylaminopropylamino)-ethyl dihydrogen phosphorothioate and S-2-(3-methylaminopropylamino)ethyl dihydrogen phosphorothioate were the most effective in antiradiation screening tests in mice, their activities being comparable to the parent compound unsubstituted on the terminal amino group. The last two compounds both provided 100% 30-day survival of lethally irradiated mice (0% survival in controls). Doses of 825 R of x rays and 1000 R of γ rays were used. (BBB)

742 EFFECTS OF A RADIOPROTECTIVE DRUG, n-DECYLAMINOETHANE THIOSULFURIC ACID, ON SUSCEPTIBILITY TO INFECTION WITH LIVE PASTEURELLA TULARENSIS VACCINE. Hodge, F. A.; Silverman, M. S. (Naval Radiological Defense Lab., San Francisco). Radiat. Eff., 1: 145-9(July 1969).

Mice were given intraperitoneal injections of the radioprotective drug, n-decylaminoethane thiosulfuric acid ($n\text{-}C_{10}H_{21}\text{-}NH\text{-}(CH_2)_2\text{-}S_2O_3H$), immediately prior to whole-body x irradiation at doses varying from sublethal (100 R) to lethal (840 R). In order to test the effect of this drug on the susceptibility of mice to infection, an attenuated living bacterial vaccine, Pasteurella tularensis (living vaccine strain, LVS), was injected subcutaneously at times varying from 1 hr to 28 days after irradiation. n-Decylaminoethane thiosulfuric acid was 100% effective in protecting non-infected mice against lethal irradiation and did not have any observable effect on nonirradiated mice infected with P. tularensis (LVS). However, if protected-irradiated mice were infected earlier than the tenth day post-irradiation, 100% deaths resulted. Cultures from autopsied mice showed large numbers of the bacterium in the liver, spleen, lymph nodes, and blood. The susceptibility of protected-irradiated mice to infection decreased as the time after irradiation increased. Thus, it appeared that a bacterial infection from a living vaccine given earlier than one week after irradiation may abolish or mask the protective effects of the drug. There appeared to be no effect of n-decylaminoethane thiosulfuric acid on the immune response of mice surviving the irradiation and subcutaneous injection of P. tularensis (LVS). Aerosol challenge with P. tularensis (LVS), which is lethal to non-immunized mice, was used to test the immunity. (auth)

743 STUDIES ON THE MECHANISMS OF ESTRADIOL-INDUCED RADIOPROTECTION. Thompson, John S.; Simmons, Eric L.; Crawford, Margaret K.; Severson, Charles D. (Univ. of Chicago, Argonne Cancer Research Hospital, Ill.). Radiat. Res., 40: 70-84(Oct. 1969).

The protective effect of 0.166 mg estradiol benzoate intramuscularly 10 days prior to total body irradiation has been redemonstrated. One milligram estradiol in propylene glycol was as effective as the benzoate, but estrone and estriol were less so and long-acting estradiol compounds were ineffective. Radioprotection conferred by pretreatment with estradiol was associated with stimulation of hematopoietic colonies in the spleen and had no relationship to immunological competence as measured by hemolytic plaque-forming cells to sheep erythrocytes. Since estradiol appeared to reduce the number of stem cells capable of migrating to the spleen and forming new hematopoietic colonies, the beneficial effects appear to be due to daughter cells that arise during the 10 days before irradiation. Whether their apparent resistance is simply due to increased numbers, or to a qualitative change in sensitivity related to cell cycle remains to be answered. (auth)

744 EFFECT OF THIAMINETETRAHYDROFURFURYL DISULFIDE ON THE RADIATION SYNDROME. Graul, E. H.; Ruether, W.; Kovacs, G. (Univ., Marburg/Lahn, Ger.). Muenchen. Med. Wochenschr., 109: 2192-7(Oct. 20, 1967). (In German).

Studies were conducted in ^{60}Co γ-irradiated mice and rats to determine whether thiaminetetrahydrofurfuryl disulfide (TTFD) has any radiation protective or therapeutic action. This vitamin B_1 derivative is not split by thiaminase. As a lipid-soluble compound, TTFD preferably diffuses into the cells and causes a protracted elevation of intracellular cocarboxylase. As coenzyme to various important enzymes of intermediate metabolism, cocarboxylase is of special importance to acute radiation mortality. After daily administration to rats or mice for 10 days the total dose reduction factor (DRF) after whole-body irradiation with doses ranging from 600 to 900 Rad was 1.34 for TTFD and 1.12 for thiamine hydrochloride (TH). The effect was smaller if a single dose of the substance was given prior to irradiation. The DRF values for TTFD were 1.2 and for TH 1.0. Furthermore, it was possible to demonstrate that the decrease of the body weight and of the weight of the small bowel caused by irradiation could be prevented or decreased by TTFD. Cell damage to the epithelium of the small bowel was considerably less in comparison to the damage in control animals. The initial mitosis inhibition of the cells in the crypts was followed by an early recovery phase. (BBB)

745 DNA SPECTROPHOTOMETRIC CHARACTERIZATION AFTER IRRADIATION IN VIVO. III. INFLUENCE OF IRRADIATION IN VITRO ON THE BEHAVIOR TOWARD DENATURING AGENTS OF DNA EXTRACTED FROM NORMAL OR IRRADIATED ANIMALS. Furnica, Maria (Institutul Oncologic, Bucharest). Rev. Roum. Biochim., 5: 199-208(1968).

Wistar rats were x-irradiated with 300- or 900-R doses, or by a 900-R dose after radioprotective treatment by AET (aminoethylisothiouronium Br: HBr) 200 mg/kg body, and killed 10 days after irradiation. Liver DNA was extracted, purified, and examined. The DNA of rats irradiated with 900 R exhibited low hyperchromicity toward heat, OH^-, and deoxyribonuclease action. To determine whether this represented helix stability or previous partial breakages of strands, another experiment was performed. The DNA extracted from normal or irradiated rats was irradiated in vitro with 40 KR and then subjected to the action of denaturing agents (heat, OH^-, DNase, H^+). Irradiation in vitro increased the lability of helix of DNA (irradiated in vivo by lethal doses) to denaturing agents that act preferably on adenine-thymine bonds (e.g., heat). The DNA irradiated in vivo behaved as normal DNA toward the denaturing action of H^+, that acts preferably on guanine-cytosine bonds. The results demonstrated that resistance to some denaturing agents exists. It may be due to some modification in the basic DNA composition or to the formation of abnormal bonds between the strands. Such modifications have biological implications, since they were produced only after irradiation by lethal doses (900 R) and never by nonlethal doses (300 R), and were detected only in the late postirradiation stage (10 days). (BBB)

746 INFLUENCE OF N-ETHYLMALEIMIDE ON RADIATION DAMAGE IN HORDEUM VULGARE AND VICIA FABA UNDER AEROBIC CONDITIONS. Rajaraman, R.; Kesavan, P. C.; Kamra, O. P. (Dalhousie Univ., Halifax, Can.). Radiat. Bot., 9: 221-3 (1969).

In studies with barley radioprotection was observed when water-presoaked seeds were treated with NEM for 4 hours before ^{60}Co gamma irradiation at 5 and 10 kR in the presence of NEM, followed by observations of seedling growth. Chromosomal aberrations were also scored at anaphase, and a considerable reduction in frequency of aberrations was observed in the NEM treated seeds. In the case of Vicia faba vigorously growing secondary roots were treated with NEM for 24 hr before subjection to 50 R of ^{137}Cs gamma irradiation. The roots were scored for chromosomal aberrations at metaphase and micronuclei at interphase at various times after irradiation. The data indicated that aerobic treatment with NEM greatly reduced the frequency of radiation induced fragments exchanges and micronuclei. It appears that NEM treatment under aerobic conditions leads to a recovery from radiation damage, and confers protection rather than the sensitization reported in some other studies. (UK)

747 RADIOPROTECTIVE ACTION OF DNA ON HUMAN CHROMOSOMES. Riggio, G.; Galimberti, A.; Cardini, G. Endocrinol. Sci. Cost., 29: 88-91(Mar. 1967). (In Italian).

The protective effect of DNA on chromosomes of human medullary cells exposed to irradiation was studied by determining the effects of the indirect action of the radiation. A moderate protective effect of DNA was noted with respect to the indirect action. It was concluded however that these impressions cannot be confirmed from present data. It must be compared with a more relevant quantitative analysis of mitosis. (tr-auth)

748 THE INFLUENCE OF COAMIDE ON THE STRUCTURE OF NERVOUS ELEMENTS IN THE SKIN AND MUSCLES IN IRRADIATED ANIMALS. Seifullin, F. Kh. (Uzbek Inst. of Roentgenology, Radiology, and Oncology, Tashkent). Byull. Eksp. Biol. Med., 68: No. 8, 113-16(Aug. 1969). (In Russian).

The influence of coamide on regeneration of nervous elements of skin and striped muscle was studied experimentally on white male rats subjected to a single dose irradiation of 88 R. The drug was administered from the 5th day after irradiation in the dose of 2 to 3 mg/kg for 20 to 25 days. Irradiated animals show marked reactive, destructive changes of nerve elements in the skin and striped muscle up to the granular breakdown of separate fibres. Coamide decreases the effect of irradiation and accelerates notably the processes of regeneration. (auth)

749 NEW ASPECTS CONCERNING THE USE OF ANABOLIC STEROIDS IN GYNECOLOGIC RADIOTHERAPY. CLINICAL AND ANIMAL INVESTIGATIONS. Picha, Engelbert (Univ., Vienna). Strahlentherapie, 138: 300-22(Sept. 1969). (In German).

Experiments with rats and mice showed that anabolic steroids can influence favorably the weight reduction and survival after irradiation; that anabolic steroids have no influence on the survival of the tumor-bearing animals or on the tumor itself; and that anabolic steroids enhance survival of whole-body irradiated and tumor-bearing animals. Anabolic agents were administered to 856 patients, during and after radiotherapy for gynecological tumors. When comparing groups of 102 patients, with stage III carcinoma, it was shown that the patients receiving anabolic agents had significantly better survival during the first three years. (auth)

750 ACID-ALKALINE EQUILIBRIUM OF THE INTERNAL MEDIA OF THE BRAIN IN ANIMALS IRRADIATED AGAINST A BACKGROUND OF PROPHYLACTIC ADMINISTRATION OF CYSTAMINE. Kuzovkov, A. G.; Ivanov, B. M. (Military Medical Academy, Leningrad). Radiobiologiya, 8: 717-20(1968). (In Russian).

The actual pH, partial pressure of carbon dioxide, sum of anionic buffers, standard bicarbonates, and deficiency of bases of the plasma of the arterial (carotid artery) and venous blood (cerebral sinus) and cerebrospinal fluid were studied in experiments on rabbits by the Astrup micromethod. Irradiation of animals at a dose of 800 R produces an uncompensated metabolic acidosis in the blood, while alkalosis is maintained in the cerebrospinal fluid on account of an increased penetration of the hematoencephalic barrier by bicarbonates and an intensified elimination of carbon dioxide. After irradiation of the animals against a background of administered cystamine, acidosis in the blood increases even more, and there was an increase in the alkalosis in the cerebrospinal fluid. (JPRS)

751 DEPENDENCE OF THE RADIOPROTECTIVE ACTIVITY OF THIOL COMPOUNDS ON THE CHANGE IN THE LEVEL OF NONPROTEIN SULFHYDRYL GROUPS THAT THEY PRODUCE IN EHRLICH'S ASCITIC CARCINOMA CELLS. Gusareva, E. V.; Tarasenko, A. G.; Graevskii, E. Ya. (Inst. of Developmental Biology, Moscow). Radiobiologiya, 8: 721-4(1968). (In Russian).

The peculiarities of the dependence of the radioprotective effect on the level of nonprotein thiols, that appear in cells under the influence of radioprotective compounds, were investigated. Cysteamine, sodium thioglycolate, mercaptoethanol, and unithiol were used as protectors. The magnitude of the protective effect was judged according to the number of Ehrlich's ascites carcinoma cells with chromosome aberrations following irradiation. The level of nonprotein SH groups in the cells was determined by amperometric titration with a 0.01 M solution of mercuric chloride. A correlation was established between the degree of radiation protection and the level of nonprotein sulfhydryl groups that appeared in cells under the influence of thiols. On the basis of the experimental and literature data, it is concluded that thiols of endogenous origin play a determining role in the radioprotective effect of drugs. (JPRS)

752 EFFECTS OF CHEMICAL PROTECTORS UNDER CONDITIONS OF FRACTIONATED IRRADIATION. 5. COMPARATIVE STUDY OF THE RADIORESISTANCE OF ANIMALS AND THEIR RESISTANCE TO THE TOXIC EFFECTS OF PROTECTORS IN CONNECTION WITH SELECTION OF THE OPTIMUM RADIOPROTECTIVE DOSE OF THE PREPARATION. Yarmonenko, S. P.; Ivanov, V. N. (Inst. of Labor Hygiene and Occupational Diseases, Moscow). Radiobiologiya, 8: 725-30(1968). (In Russian).

A comparative study was made of the radiosensitivity of five different lines of mice and their resistance to the toxic effects of radioprotective compounds (AET and mexamine). As a rule, a positive correlation was observed between the parameters studied, which is considered in support of the concepts of a genetically determined relation between the radiosensitivity of the organism and its total nonspecific sensitivity. It was also shown that in the case of single and fractionated irradiation of mice at the average lethal doses, the maximum protective effect is achieved by selection of the optimum (rather high, but far from toxic) dose of thiol protectors, AET and mexamine, that proves to be lower than the amounts of the same preparations usually used in experimental radiobiology. (JPRS)

753 STATE OF THE RAT THYROID GLAND AFTER FRACTIONATED X IRRADIATION WITH PROPHYLACTIC ADMINISTRATION OF CYSTAMINE. Nenarokova, L. I.; Antipenko, E. N. (Military Medical Academy, Leningrad). Radiobiologiya, 8: 731-5(1968). (In Russian).

After fractionated x irradiation at a dose of 750 R (75 R × 10 at three-day intervals), substantial disruptions of the structure and function of the thyroid gland of rats were detected. Maximum accumulation of ^{131}I was reduced by 25%, the weight of the gland was increased, the amount of the colloid was increased, and the oxygen consumption by the animals was reduced. Repeated administration of cystamine to nonirradiated animals produced a substantial decrease in the weight of the thyroid gland and a drop in the amount of colloid in it. The use of cystamine in the case of exposure to a fractionated dose of radiation did not lead to any decrease in the radiation damage to the thyroid gland. (JPRS)

754 MECHANISM OF THE RADIOPROTECTIVE EFFECTS OF AMINOTHIOLS. Tiunov, L. A.; Vasil'ev, G. A. Radiobiologiya, 8: 756-7(1968). (In Russian).

Experiments on white mice irradiated by x rays showed that the radioprotective effect of 1-cysteine can be enhanced by combining this aminothiol with one of the inhibitors of xanthine oxidase, 2-amino-4-methyl-(1',2',3'-oxadiazol-(5,6-4',5')-pyrimidine. It was concluded that a definite role in the mechanism of the antiradiation action of aminothiols is played by endogenous sulfhydryl groups, since the inhibition of xanthine oxidase inhibits the rate of oxidation of reduced glutathione. (JPRS)

755 TOPICAL TREATMENT OF LOCAL RADIATION EFFECTS WITH A COMBINATION OF CORTICOIDS, ANTIBIOTICS, AND VITAMINS. Kleibel, Franz (Univ., Heidelberg). Strahlentherapie, 138: 209-12(Aug. 1969). (In German).

A drug preparation containing corticoids, antibiotics, and vitamins (Corti-Flexiole) was administered to 48 patients during radiation therapy with fast electrons or γ rays. It was used therapeutically in 20 cases and prophylactically in 28 cases. A favorable subjective and objective effect was obtained in the reactions of the skin and mucosa in the oro-nasal and in the ano-genital region. This drug has a pronounced anti-phlogistic and anti-exudative effect. Secondary effects were not observed. (auth)

756 STUDIES OF TREATMENT COMBINING RADIATION AND CYTOSTATIC AGENTS. PART 6. ADDITIONAL STUDIES ON 5-FLUOROURACIL AND OTHERS. Ringleb, Dietrich; Bosnar, Marijan; Krieg, Robert; Sauer, Dieter; Steckenmesser, Rainer (Univ., Giessen, Ger.). Strahlentherapie, 138: 218-23 (Aug. 1969). (In German).

The effects of fractionated radiotherapy in combination with cytostatic drugs (5-Fluoro-Uracil, Natulan, or Proresid) were studied on the weight of testes in mice and on the growth of the tail of young mice. The effect of post-radiotherapy chemotherapy was also studied on the wound healing of a punched ear and on the evolution of the skin reaction due to heavy doses on the tail. For these three drugs, as for Endoxan a synergistic effect is observed on the germinal epithelium and on young and proliferative tissues. The evolution of the radiation reaction was temporarily delayed by the alkylating and antimitotic agents, enhanced by the antimetabolite. (auth)

757 STUDIES ON THE METABOLISM OF TETRAHYMENA PYRIFORMIS GL. V. PROTECTIVE EFFECT OF SULFHYDRYL SUBSTANCES AGAINST γ IRRADIATION. Van de Vijver, G. (State Univ., Ghent). Enzymologia, 36: 375-85(June 30, 1969).

Study of the effect of γ irradiation on the respiratory rate of the ciliated protozoan Tetrahymena pyriformis (strain GL) indicated that this organism was very resistant to the action of ionizing radiation; also, that its radiosensitivity depended largely upon experimental conditions. Investigation of chemical protection against irradiation damage by sulfhydryl substances indicated the importance of physiological conditions when SH protectors were added to living cells. The radioprotective effect of six sulfhydryl substances (L-cysteine, reduced glutathione, cysteamine, cystamine, β-aminoethylisothiouronium, and British Anti-Lewisite) on irradiated whole cells was studied manometrically with the standard Warburg technique. Irradiation was performed with a ^{60}Co source at a dose rate of 555.5 to 325.0 kR/hr and doses of 0.2 to 0.5 MR. Experiments with cells suspended in tap water indicated toxic effects of the compounds added before irradiation, so that protection in water was excluded. However, with ciliates suspended in phosphate buffer of neutral or slightly alkaline pH, the results were positive, protection being afforded by the –SH substances. It was concluded that the toxic influence of the compounds observed after irradiation in water was due to an increased H_2O_2 yield as well as to an inactivation of the enzyme catalase. On the other hand, protection as measured with cells suspended in phosphate buffer at a given pH was due to a double synergistic effect; H_2O_2 formation was decreased and inactivation of the catalase did not occur. Since the decrease of hydrogen peroxide formation resulted in a higher free radical yield and the protective effect was positive, it was concluded that the sulfhydryl substances acted by scavenging radicals. (BBB)

Radiation Sickness and Injuries

Refer also to abstract 594.

Radiodiagnosis

Refer also to abstracts 708, 723, 724, 729, 730, 876, and 1972.

758 (NYO-910-123) BIOLOGICAL EFFECTS OF RADIATION AND RELATED BIOCHEMICAL AND PHYSICAL STUDIES. PROPOSAL NO. 3. METABOLIC STUDIES IN CANCER WITH RADIOACTIVE ISOTOPES. Progress Report, May 1, 1968–May 1, 1969. Laughlin, John S.; Myers, W. P. Laird (Sloan-Kettering Inst. for Cancer Research, New York). Sept. 30, 1969. Contract AT(30-1)-910. 41p. Dep. CFSTI.

Data processing and recording systems for use in computer analysis of data from radioisotope scans were improved to provide a more rapid and reliable means of recording scan data. Instrumentation for use with the Anger camera was developed to provide stationary imaging of nuclide distributions in vivo for both single γ emitters and positron emitters with computer analysis of the data. The use of ^{52}Fe and ^{99}Tc-sulfur colloid for whole-body scanning to visualize erythropoiesis in active bone marrow proved to be of value in the diagnosis of questionable leukemias. The use of acid-citrate dextrose to damage ^{51}Cr- and ^{48}Cr-labeled erythrocytes for use in spleen scanning was investigated. Gaseous ^{13}N and ^{133}Xe were evaluated for use with γ cameras for pulmonary function studies. Scanning with ^{47}Ca, ^{18}F, ^{85}Sr, or ^{87}Sr for the detection of occult primary and metastatic bone neoplasms, and the effects of radiation therapy on the uptake and retention of ^{47}Ca and ^{85}Sr in bone lesions were investigated. The uptake of ^{47}Ca in the bones of patients with hyperparathyroidism and the use of ^{75}Se-selenomethionine or ^{11}C-toluidine blue for preoperative localization of parathyroid tissue were also studied. (C.H.)

759 COMPARISON OF SCINTIGRAPHY AND X-RAY DIAGNOSIS IN OSTEOMYELITIS. Hoer, G.; Frey, K. W.; Keyl, W.; Hertel, E. (Univ., Munich). Fortschr. Geb. Roentgenstr. Nuklearmed., 110: 708-16(May 1969). (In German).

Bone scanning, using ^{85}Sr or ^{87m}Sr, was compared with radiography in 13 hematogenous and 26 exogenous posttraumatic, or post-operative, cases of osteomyelitis. In the presence of diffuse bone involvement, radiology provided more information than scanning (8×). In the presence of localized foci, or of foci within diffuse osteomyelitis, scanning more often provided valuable information (12×). The value of scanning as an addition to radiological diagnosis consists in revealing localized bone foci. The demonstration of sequestra, operative defects, and pseudarthrosis depends on radiological diagnosis. (tr-auth)

760 NEW METHOD TO EVALUATE SCINTIGRAMS USING A TELEVISION SUBTRACTION APPARATUS. Huehn, E. A. (Staedtische Krankenanstalten, Dortmund, Ger.). Fortschr. Geb. Roentgenstr. Nuklearmed., 110: 734-8(May 1969). (In German).

A new method for isotope diagnosis, using a piece of apparatus developed for radiological diagnosis, is described. Use of a television subtraction device makes it possible to eliminate interference by neighboring organs. Investigations using phantoms show that no reduction in the geometric definition as a result of this procedure exists. (F. St.)

761 RADIOEPHROGRAPHY WITH ^{131}I-HIPPURAN IN STUDIES OF POST-OPERATIVE KIDNEY FUNCTION IN PATIENTS WITH RENOVASCULAR HYPERTENSION. Semprebene, L.; Fiorani, P.; Benedetti-Valentini, F. Jr.; Pistolese, G. R.; Citone, G.; Tata, M. V. (Univ., Rome). Acta Isotop., 8: 191-205(Oct. 30, 1968). (In Italian).

Forty-five patients with renovascular hypertension, treated by reconstructive procedures, were controlled using radionephrography with Hippuran-^{131}I. The check-up was initially performed 12 to 24 hr post-operative and repeated every following day. Thirty-two patients were controlled also after the first month. Radionephrography proved to be an extremely useful technique to evaluate the changes in the vascular districts of the kidney during the post-operative course. In addition it was possible to explore the hemodynamic response of the controlateral kidney. (auth)

762 IDENTIFICATION OF CEREBRAL DIFFUSION BY SCINTIGRAPHY USING ^{131}I-MAA. Bonanno, N.; Meduri, M.; Salvi, L. (Univ., Messina, Italy). Acta Isotop., 8: 141-8 (Oct. 30, 1968). (In Italian).

The present day concepts about the brain luxury perfusion syndrome and the potential diagnostic applications of MAA-^{131}I brain scanning are discussed. The first scintigraphic documentation of a luxury perfusion syndrome in a patient with cerebral embolism is presented. The importance of MAA-^{131}I brain scanning in detection of segmental circulatory defects is emphasized. (auth)

763 SCINTIGRAPHIC PATTERNS OF RENAL NEOPLASMS. Sanguineti, M.; Durand, D. (Ospedali Galliera, Genoa). Acta Isotop., 8: 149-58(Oct. 30, 1968). (In Italian).

In 35 patients with proven renal tumors, the occurrence of five different scintigraph patterns was observed. It is thought that, in spite of the fact that the scintigraphic image is not specific, the presence of a malignancy may be suspected whenever the scintigram shows a cold spot and hypoactivity in the surrounding area. In all other cases the renal scintigraphic examination seems to supply useful information complimentary to the routine radiological studies. (auth)

764 BONE SCINTIGRAPHY USING ^{85}Sr IN DIAGNOSIS OF VON RECKLINGHAUSEN'S DISEASE. Ferlin, G.; Conte, N. (Univ., Padua). Acta Isotop., 8: 113-23(Oct. 30, 1968). (In Italian).

In two cases of primary hyperparathyroidism ^{85}Sr bone scintiscan showed not only an increased tracer activity in the osteolytic areas seen on x rays but also an uptake in areas that radiologically looked normal. Due to the fact that this tracer seems to concentrate in any zone that shows osteogenic activity, it may be useful in Von Recklinghausen's disease. It may reveal in fact the number and the extent of bone lesions. (auth)

765 APPLICATIONS OF SCINTILLATION CAMERA IN STUDY OF THYROID DISEASES. Ferlin, G.; Conte, N.; Ziliotto, D. (Univ., Padua). Acta Isotop., 8: 125-32(Oct. 30, 1968). (In Italian).

A thyroid phantom and 40 patients with thyroid diseases were examined using a scintillation camera as well as a conventional scanner. Comparable results were obtained with the two systems,

both of which were able to detect cold nodules of about 1 cm in diameter. However, using the camera the time required to carry out the examination was 3 to 5 times shorter than using the scanner. Because of this and of its satisfactory resolution, the scintillation camera will probably find a widespread application in the study of the thyroid gland. (auth)

766 LYMPHOGRAM CHANGES CAUSED BY SURGERY AND IONIZING RADIATION. A STUDY OF REGENERATION IN THE LYMPH SYSTEM. Ludvik, W.; Wachtler, F.; Zaunbauer, W. (Univ., Vienna). Fortschr. Geb. Roentgenstr. Nuklearmed., 110: 307-21(Mar. 1969). (In German).

The effect of ionizing radiation on the lymphatic system in 47 patients among a total of 224 lymphograms was investigated. Early and late reactions were observed; despite reduction in size of lymph nodes and narrowing of the lumen of lymphatics, delay in contrast flow was observed only in the presence of radiation fibrosis. After removal of pelvic lymph nodes, functional compensation was observed, whereas excision of inguinal nodes led to oedema. Experiments on Minnesota pigs confirmed the observation that interruption of the lymphatic chain in granulation tissue resulted in regeneration of lymphatic vessels, but not of lymph nodes. The development of small lymph nodes in these animals, as in man, was observed only in the pelvis and never in the inguinal region. (auth)

767 PRINCIPLES OF STOMACH SCINTIGRAPHY FOR USE IN ROUTINE CLINICAL PROCEDURES. Fridrich, R.; Engelhart, G. (Univ., Basel). Fortschr. Geb. Roentgenstr. Nuklearmed., 110: 328-36(Mar. 1969). (In German).

Radio-iodine and ^{99m}Tc show the same organ affinity, but have different biochemical behavior in the thyroid gland, the salivary glands and the stomach. Investigations concerning technetium transport indicate that functioning gastric wall is able to concentrate intravenously administered ^{99m}Tc and to excrete it in quantities proportional to the gastric juice. Gastric tissue infiltrated by neoplasm shows disturbed function in this respect. Technetium transport is partially, or completely interrupted. With scanning it is possible to demonstrate functional gastric wall as a positive contrast source. Areas with diminished function can be recognized by their reduced activity. In contrast, inflammatory changes in the stomach wall do not show any primary disturbance of technetium transport. Localized or diffuse inflammatory processes are therefore not recognized. The most useful application for ^{99m}Tc scanning is therefore in the diagnosis of malignant disease in the stomach, since it enables differentiation between inflammatory and neoplastic conditions. In view of its physical characteristics, ^{99m}Tc is preferable to ^{131}I. (auth)

768 ^{125}I ABSORPTION IN THE FINGER BONES AS MEASURED BY SCANNING. QUANTITATIVE METHOD FOR DIAGNOSIS OF OSTEOPOROSIS. Boerner, W.; Grehn, S.; Moll, E.; Rauh, E. (Univ., Wuerzburg, Ger.). Fortschr. Geb. Roentgenstr. Nuklearmed., 110: 378-87(Mar. 1969). (In German).

Improved methods for the diagnosis of osteoporosis are discussed. For this purpose, a profile scanner with an ^{125}I source is used, absorption across a phalanx being measured in two planes. Evaluation is based on a realistic model of a finger. A series of absorption curves have been calculated for this, with variation of absorption coefficient. The results obtained form the basis for a series of diagrams which can be used for estimating the values of the curves obtained from actual patients. The method permits separate estimation of the absorption coefficient of compacta and spongiosa. Our results up to the present (133 patients) show that only the absorption coefficient of the spongiosa is relevant in the diagnosis of osteoporosis. Diagnostic accuracy is thought to be better than other, existing, methods. (auth)

769 LIEGE WHOLE BODY COUNTER. II. MEASUREMENTS OF TOTAL BODY POTASSIUM. PRELIMINARY CLINICAL RESULTS. Delwaide, P. A. (Univ. de Liege). Ann. Biol. Clin. (Paris), 27: 341-54(May-June 1969). (In French).

The Liege whole-body counter permits measurement of the total potassium in controls and in a certain number of pathological cases. The preliminary results show a rather small variation from normal values when related to homogeneous groups with respect to sex, age and weight. Statistically significant lower values are obtained in cirrhosis, diabetes controlled without insulin, essential hypertension and previously treated hyperthyroidism. On the other hand, cases of diabetes treated with insulin and angina without infarction have average values which do not differ from normal. Renal insufficiency is characterized by a wider range of variations. (auth)

770 THE STUDY OF ^{57}Co-VITAMIN B_{12}-ABSORPTION USING A WHOLE-BODY COUNTER. Naversten, Y.; Liden, K.; Stahlberg, K. G.; Norden, A. (Univ. of Lund, Sweden). Phys. Med. Biol., 14: 441-53(1969).

A study of the absorption of vitamin B_{12} labeled with ^{57}Co was performed by whole-body counting. The subjects were measured in prone and supine positions by a NaI(Tl) scintillation detector which moved 150 cm along the subject. The technique was evaluated by model studies, by whole-body counting of subjects and by radioactivity assay of excreta. The influence of body size upon the whole-body counter sensitivity was demonstrated. This influence was considerably diminished when the Compton energy range instead of the photopeak energy range was used for the determination of the radioactivity in the body. (auth)(UK)

771 SYSTEM LB910: A COMBINATION PROGRAM FOR NUCLEAR MEDICINE. Berthold, F.; Kuni, H.; Trost, A. Messtechnik, 77: 42-6(Feb. 1969). (In German).

A modular system for nuclear medicine is described. Its field of application covers all in vitro tests like T3 and Schilling tests, iodine uptake tests, and blood volume determinations. The novel part is a logic and display unit allowing to store, subtract, and divide pulse counts. The result is displayed directly in percent for the activity ratio of two samples or in liters for blood volume determination. (tr-auth)

772 AN ANALYSIS OF TECHNETIUM ($^{99m}TcO_4^-$) KINETICS: THE EFFECT OF PERCHLORATE AND IODIDE PRETREATMENT. Welch, M. J.; Adatepe, M.; Potchen, E. J. (Washington Univ., St. Louis). Contract AT(11-1)-1653. Int. J. Appl. Radiat. Isotop., 20: 437-45(June 1969). (COO-1653-38).

Pretreatment with perchlorate or iodide prior to technetium brain scanning has been advocated to reduce the radioactivity emanating from the choroid plexus. By blocking tissue technetium uptake this pretreatment may alter the blood background significantly. The kinetics of technetium disappearance from the blood and body distribution were evaluated in multiple blood samples withdrawn from 21 patients who were having technetium brain scans. The patients were divided into three groups: (1) control; (2) pretreated with perchlorate; and (3) pretreated with iodide. The activity of the blood was plotted against time and trends were found to fit the model:

$$\text{Tissue-}^{99m}\text{Tc} \underset{k_3}{\overset{k_2}{\rightleftharpoons}} \text{Blood-}^{99m}\text{Tc} \xrightarrow{k_1} \text{Urine-}^{99m}\text{Tc}$$

The tissue compartment appeared almost completely blocked by the perchlorate or iodide and the rate constants were found to be $k_1 = 0.19\ hr^{-1}$, $k_2 = 1.47\ hr^{-1}$, $k_3 = 1.7\ hr^{-1}$. From these observations it is concluded that equimolar perchlorate and iodide have similar effects on technetium body distribution kinetics and almost completely block a large segment of tissue accretion. These observations provide useful dosimetric data for assessing the effect of iodide or perchlorate pretreatment upon the biologic half life (tissue residence) of pertechnetate and suggest that the optimal time for brain scintiscanning in patients pretreated with perchlorate or iodide is somewhat later than that usually allowed (shortly after the intravenous injection of technetium). (auth) (UK)

773 SURVIVAL STUDIES ON A COMMERCIAL PREPARATION OF INTRAVENOUS HUMAN GAMMA GLOBULIN LABELLED WITH ^{131}I. Wells, J. Vivian (New South Wales Univ., Kensington, Australia). Australas. Ann. Med., 18: 271-6(Aug. 1969).

The biological activity of a new preparation of human gamma globulin (HGG) was assessed by performing metabolic protein survival studies with ^{131}I-labeled HGG (C.S.L.). The subjects included two normal controls and one patient each with cirrhosis, G-myeloma and hypogammaglobulinaemia. In addition to IgC, the HGG (C.S.L.) contained 33 mg/100 ml IgM, less than 10 mg/100 ml IgA, and no detectable complement (as C'_3) when assessed by immunological techniques. There were no reactions to the injected ^{131}I-HGG (C.S.L.), but all subjects showed significantly increased urinary excretion of free ^{131}I in the initial 48 hours of the turnover study. This suggested that a proportion of IgG molecules in the HGG (C.S.L.) had been structurally altered during preparation. The catabolism of HGG (C.S.L.) was abnormally increased in normal controls, with a short half-life and increased fractional turnover rate. In hypogammaglobulinaemia, both the plasma half-life and fractional turnover rate were normal, and further studies and clinical trials on the efficacy of this preparation in this disease are warranted. (Australia)

774 ^{99m}Tc AND ^{113m}In SCANS IN 101 INTRACRANIAL TUMORS. Handa, Hajime; Handa, Jyoji; Nabeshima, Akio; Sato, Kouzo; Torizuka, Kanji; Kousaka, Tadako (Kyoto Univ.). No To Shinkei, 21: 43-51(Jan. 1969). (In Japanese).

Brain scanning using ^{99m}Tc and ^{113m}In for detection of intracranial tumors is described. The overall results in 101 cases with brain tumors showed a diagnostic accuracy of 75%. Meningiomas, glioblastomas, and metastatic tumors were diagnosed with 90% accuracy. Results were unsatisfactory in tumors located infratentorially or near the base of the brain. Among supratentorial

tumors, a temporal mass was not readily detected when compared with those in the frontal, parietal, or occipital region. No significant difference was noted in diagnostic accuracy between ^{99m}Tc and ^{113m}In brain scans. The combination of brain scanning and conventional neuroradiological contrast studies (air injection studies and arteriography) made possible the detection of surgically verified lesions with an overall accuracy of 100%. The combination of brain scannings with plain x-ray films, ophthalmological examinations, and EEG recordings yielded a diagnostic accuracy of 99% in the 101 cases. The possibilities of predicting tumor pathology and of detecting recurrent tumors by use of brain scanning were discussed. (BBB)

775 IRRADIATION AND THE FETUS. Prem, Konald. Minn. Med., 51: 503-5(Apr. 1968).

Hazards of diagnostic radiation used during pregnancy and means to minimize fetal exposure are briefly reviewed. At present, x-ray pelvimetry offers the only method by which cephalopelvic disproportion can be accurately assessed. Although many radiographic techniques have been described for measuring the pelvis, the exposure of the maternal and fetal gonads and fetal whole-body radiation from x-ray pelvimetry remain significant. Exposure can be reduced by reduction of views from three or four to two, and by use of other refinements of radiation technique such as proper coning, filtration of the beam, proper positioning of the patient to minimize the need for repeat films, the use of high kilovoltage, high speed screens and films, long tube-to-film distance and rapid developing solutions. All of these measures further reduce the radiation exposure needed for quality radiographs. The value of placentography in the management of suspected placenta previa is probably greatly overrated. Unlike cephalopelvic disproportion, most suspected cases of placenta previa can be managed adequately without maternal or fetal exposure to radiation. If the clinician believes that exact location of the placenta is important, radiation exposure of mother and fetus is drastically reduced by the fairly accurate ^{99m}Tc-albumin scanning technique. The use of the nonradiologic means now available, such as amniocentesis, determination of maternal urinary estriol excretion, fetal electrocardiography, and ultrasound, have reduced or eliminated the need for radiologic techniques in the evaluation of some other clinical obstetrical problems such as fetal maturity, excessive uterine enlargement, and suspected fetal death. (BBB)

776 SCINTIGRAPHIC FINDINGS IN RENAL TUMORS. Hennig, K.; Franke, W.-G.; Woller, P.; Kirsch, E. (Carl Gustav Carus Medizinische Akademie, Dresden). Deut. Gesundheitsw., 31: 1610-15(Aug. 21, 1969). (In German).

Scintigraphic results of examinations of 66 patients suffering from renal tumors were reported. In all cases both malignomata and cysts manifested themselves in the scintigram. Characteristic symptoms of the scintigraphic picture were observed that occurred either only with malignomata (apart from one exception) or only with cysts, in about 50% of the patients. The position of renal scintigraphy among the diagnostic measures taken as far as renal tumors are concerned, are discussed. (auth)

777 ANGIOGRAPHIC AND SCINTIGRAPHIC STUDIES OF RARE BONE TUMORS. Diethelm, L.; Fischer, W.; Habighorst, L. V.; Schweikert, C. H.; Wessinghage, D. (Johannes Gutenberg Univ., Mainz). Radiologe, 9: 311-17(Sept. 1969). (In German).

The angiographic and scintigraphic findings in four primary bone tumors (Chondromyxoid fibroma, mesenchymal chondrosarcoma, aneurysmal bone cyst, and malignant giant cell tumor) are reported. According to these findings, the value of various angiographic signs in bone tumors are discussed. A synopsis of all vascular symptoms seen in tumor angiography is shown in a table. Scintigrams of these bone tumors after application of ^{99m}Tc-Iron(II)-complex and ^{87m}Sr-citrate are added and discussed. (auth)

778 TEACHING RADIOGRAPHIC TECHNIC WITH A DENTAL PHANTOM. O'Shaughnessy, Philip E.; Schimmele, Ralph G. (Indiana Univ., Fort Wayne). J. Dent. Educ., 32: 466-51(Dec. 1968).

After a brief survey of the hazards of ionizing radiation and the lowest acceptable doses in dental radiography, a method is described whereby dental students can be instructed by the use of a phantom in keeping radiation exposure to a minimum. The National Committee on Radiation Protection and Measurements recommendations for maximum permissible doses are discussed. Although the radiation doses a patient receives from the usual oral procedure are very low, it must be considered that all radiation is harmful and should be used only when it is indicated specifically. The phantom described has adjustable arms as well as fingers that can be used to hold films in place when the digital method is employed. The mandible is movable, and it can be situated so that the mouth is open or closed. The jaws contain human teeth, and the head, cheeks, tongue, and other structures are composed of flexible material approximating human tissue. It was shown that students, by employing the phantom, could be taught radiographic technic as well as with patients. From the standpoint of radiation hazards associated with patient irradiation, the use of the phantom is preferred. (BBB)

779 PROBLEMS OF PROTECTION IN DENTAL RADIOLOGY. Torres, Murilo Barbosa. Rev. Brasil. Odontol., 25: 125-36(May-June 1968). (In Spanish).

The physical nature of x rays and their biological effects are briefly examined. Some concepts and definitions are explained. The principal protective means used to minimize the harmful effects of x rays used in dental radiology are described. (tr-auth)

780 MEDICAL X-RAY VISITS AND EXAMINATIONS DURING PREGNANCY. Brown, Morton L. (National Center for Radiological Health, Rockville, Md.); Nelson, Arne B. Vital Health Statist., 22: 1-41(June 1968).

The extent of exposure of pregnant women to ionizing radiation in the United States was assessed by a questionaire method. Statistics are presented on the number of medical x-ray visits and examinations during pregnancy of women who had a live birth during 1963. Differences in the volume of medical x-ray exposure are shown by such demographic characteristics as color, age, income, geographic region, and residence in metropolitan or nonmetropolitan areas. Other variables include type of medical facility, type of examination, trimester of examination, and previous pregnancy experience. The data are based on a probability sample of 4096 births occurring in 1963. About 900,000, or 23%, of the women giving birth in 1963 had 1,085,000 medical x-ray visits during pregnancy. A higher proportion of nonwhite mothers than white had medical x-ray tests. About ⅓ of the examinations during the last trimester were for x-ray pelvimetry and 24% were examinations of the abdomen, that were related to pregnancy. Examinations during the first and second trimesters were predominantly of the chest. (BBB)

781 RADIOISOTOPE RENOGRAMS OBTAINED BY SCINTILLATION CAMERA WITH ELECTRONICALLY SPLIT SCREEN. Petersen, F.; Trapp, P.; Adam, K. (Institut fuer Strahlentherapie und Nuklearmedizin, Hamburg). Therapiewoche, 19: 1111-14(June 11, 1969). (In German).

After injection of iodine-131-labeled orthohippuric acid, conventional renograms were obtained and compared with pictures from a scintillation camera. This combination markedly increased the yield of diagnostic information, although the patterns obtaines were not characteristic for any specific renal disease as to location and degree of functional disturbances for each kidney. (H.B.G.)

782 DIAGNOSTIK DER KNOCHEN- UND GELENKKRANKHEITEN NACH FUEHRENDEN ROENTGENSYMPTOMEN. (Radiodiagnostic Methods for Bone and Joint Diseases). Deak, P.; Fried, L. A. Budapest, Akademiai Kiado, 1966. 547p. $17.00.

In the case of disease, bones react with changes of mineralization and structure. These changes are detected by x-rays. Pathologic conditions lead either to an increase or a decrease in mineralization with corresponding changes in x-ray density. Occasionally, the two processes occur simultaneously and produce a mosaic picture. Five major subjects are discussed in relation to this: bone changes with increased x-ray penetration; bone changes with decreased penetration; mosaic bone changes; bone changes leading to special structure alterations; and diseases of joints. (H.B.G.)

783 ACCURACY OF DIAGNOSTIC SCINTIGRAMS OF LIVER METASTASES: COMPARISON WITH AUTOPSY FINDINGS. Georgi, Max; Misri, Hassan; Sonderkamp, Horst; Kempmann, Gerd (Univ., Heidelberg). Strahlentherapie, 138: 157-61(Aug. 1969). (In German).

When the scintigraphic images were compared with the observations made at autopsy in our cases, it was concluded that liver scanning allows detection of liver metastases in 68%. Metastases of a diameter of four cm are easily detected, and this seems to be the inferior limit. Below two cm metastases cannot be detected, and when large in number the image is difficult to differentiate from a diffuse parenchymatous disease. (auth)

784 SIMILARITY IN DISTRIBUTION OF SKELETAL BLOOD FLOW AND ERYTHROPOIETIC MARROW. Van Dyke, Donald (Univ. of California, Berkeley). Clin. Orthop., 52: 37-51(1967).

Methods using a positron scintillation camera were developed for ^{18}F, ^{52}Fe, and ^{55}Fe studies of skeletal blood flow, and were tested in rats, dogs, rabbits, monkeys, opossums, and humans. Radiation exposures of various tissues from the injected doses are calculated. Images of positron emitters were produced by detecting in coincidence the γ-ray pairs that came from positron annihilation. The distribution of ^{18}F in the skeleton was determined by taking positron camera pictures 1 hr after its intravenous administration. Because of its 2-hr half-life, ^{18}F delivers a relatively

small radiation dose to the patient. Half of the administered dose is normally excreted via the urine. With a dose of 200 μCi the highest integral radiation dose to the bladder is about 0.5 to 1 rad. The average dose received by the rest of the body, excluding bone, is less than 20 mrad. Areas of bone that concentrate ^{18}F receive a higher dose that is difficult to estimate. However, in an extreme case where $1/10$ of the administered dose is taken up by 10 g of bone, the radiation dose is still below 1 rad. Iron-52 has an 8.2-hr half-life and decays 57% by positron emission and 43% by electron capture to the radioactive daughter (metastable) ^{52m}Mn. The daughter decays 100% by positron emission with a half-life of 21.3 min. The scintillation camera detects annihilation radiation from both nuclides, and there is no method of discriminating between them. The ^{52m}Mn evidently remains where it was formed by ^{52}Fe decay, or at least does not concentrate in any specific organ. The upper limit of radiation dose to the bone marrow of a normal adult was calculated to be 2.5 R/100 μCi dose, if immediate uptake of the ^{52}Fe in 1500 g of marrow is assumed, and if ^{52m}Mn decays in the marrow. The irradiation is delivered almost entirely by positrons before they are converted to γ-ray pairs. The average range of the positron is a few millimeters in soft tissue. Therefore, the fat associated with marrow is irradiated, and its mass is included in the dose calculations. A small amount of ^{55}Fe (~5 μCi) is produced when 100 μCi of ^{52}Fe is made by bombardment of natural chromium. The half-life of ^{55}Fe is 2.6 yr, but it decays entirely by electron capture and emits only 5.5-keV x rays. This radiation is not detectable by the scintillation camera. The permitted continuous body burden of this isotope is 1 mCi so the few microcuries administered are of no practical consequence. Pictures were taken about 16 hr after intravenous administration of 50 to 150 μCi of ^{52}Fe, when its uptake in marrow is maximum and its concentration in the blood is low. Results of distribution of these 3 radioisotopes are illustrated. (BBB)

785 EFFECTS OF ABERRANT VESSELS ON THE RENAL SCINTIGRAM. Deininger, H. K.; Heuck, F. (Zentral-Roentgeninstituts des Katharinenhospitals, Stuttgart). Fortschr. Geb. Roentgenstr. Nuklearmed., 111: 397-406(Sept. 1969). (In German).

In eight patients evidence of urinary obstruction dependent on body position was demonstrated by an isotope nephrogram without similar evidence on excretion urography. At operation or renal angiography, aberrant arteries to the lower poles of the kidneys were demonstrated. These acted as an obstruction to the ureter or renal pelvis depending on the position of the patient. The discrepancy between the results of the isotope nephrogram and the excretion pyelogram probably depends on the intermittent nature of the obstruction. These observation suggest a means for the early diagnosis of obstructing aberrant vessels to the kidneys. (auth)

786 A SIMPLIFIED METHOD FOR SIMULTANEOUS ELECTROLYTE STUDIES IN MAN UTILIZING ^{43}K. Skrabal, F.; Glass, H. I.; Clark, J. C.; Jeyasingh, K.; Joplin, G. F. (Hammersmith Hospital, London). Int. J. Appl. Radiat. Isotop., 20: 677-81(Sept. 1969).

A method is presented which enables the exchangeable sodium, potassium, and bromide space to be estimated entirely by gamma counting using sodium-24, potassium-43, and bromine-82. The potassium-43 is a cyclotron produced isotope with a 22-hr half-life. The principal gamma radiation is at 370 keV. Duplicate estimations on nine patients indicated that the error in the estimation in exchangeable sodium, exchangeable potassium and bromide space is 4.6, 2.78, and 2.14%, respectively. By using a dual channel automatic gamma counter the assay may be completed in a single counting run. This technique permits a more widespread application of these measurements in clinical research and diagnosis. (auth) (UK)

787 PULMONARY CIRCULATION IN OVERINFLATION OF THE LUNG. EFFECT OF AIRWAY OBSTRUCTIONS. Felix, R.; Havers, L.; Winkler, C.; Duex, A.; Boldt, C.; Thurn, P.; Claussen, G.; Freiberger, P. (Univ., Bonn). Fortschr. Geb. Roentgenstr. Nuklearmed., 111: 55-67(July 1969). (In German).

Over-inflation of a lung is associated with increased pulmonary resistance, as can be demonstrated indirectly by scanning and by angiography. This is due to compression of small vessels and increase in their length. On the other hand, there is no change in the diameters of the central arteries and veins. Dilatation of the central arteries with simultaneous constriction peripherally, as a result of pulmonary arterial hypertension, is explained by the different stretch responses of these arterial segments during increased intravascular pressures. (auth)

788 SCINTIGRAPHIC STUDIES OF BLOCKADE OF CENTRAL BRONCHII BY CARCINOMA WITHOUT ATELECTASIS AND OBSTRUCTION OF MAJOR VESSELS WITH COLLATERAL CIRCULATION. Schulze, W. (Radiologische Zentralinstitut des Krankenhauses Nordwest, Frankfurt am Main). Fortschr. Geb. Roentgenstr. Nuklearmed., 111: 43-54(July 1969). (In German).

Collateral air drift and collateral circulation prevent development of the classical radiological features usually caused by an obstructing bronchial carcinoma, by preventing the expected disruption of ventilation and circulation. Collateral air drift is confined to parts of the lung obstructed by tumor. Haemodynamic changes result from obstruction of a main bronchus or main pulmonary artery and consist in the development of a collateral (bronchial-pulmonary) circulation. The functional effects can be shown more clearly by lung scanning following the intravenous injection of radioactive particles than by radiographic studies. The scan may demonstrate the presence of neoplastic bronchial occlusion in a nonatelectatic pulmonary segment. (auth)

789 LOCALIZATION OF THE PLACENTA BY DIAGNOSTIC NUCLEAR MEDICINE. Weber, J. (Allgemeinen Krankenhaus Altona, Hamburg). Fortschr. Geb. Roentgenstr. Nuklearmed., 111: 427-36(Sept. 1969). (In German).

A method of placental localization using ^{99m}Tc is reported (^{99m}Tc/hlv 6 hr/1 μCi Pertechnetate intravenously). Scanning with ^{99m}Tc has considerable advantages compared with other isotopes and produces little radiation for mother or child. Problems of dose and localization are discussed. The method is considered to be superior to other procedures such as echo-placentography or thermography. Indications are the suspicion of placenta praevia and bleeding in the second half of pregnancy, and for placental localization in the presence of rhesus incompatibility. (auth)

790 SCINTIGRAPHIC EVALUATION OF PANCREATIC FUNCTION BY DETERMINING INTESTINAL RADIOACTIVITY OF ^{75}Se. Deininger, H. K.; Heuck, F. (Zentral-Roentgeninstituts des Katharinenhospitals, Stuttgart). Fortschr. Geb. Roentgenstr. Nuklearmed., 111: 420-6(Sept. 1969). (In German).

^{75}Se activity from the upper bowel frequently interferes with pancreatic scanning, but this is less common in the presence of acute pancreatitis or pancreatic tumors. It was impossible to differentiate between benign and malignant pancreatic tumors, nor was it possible to determine the extent of destruction of the pancreatic parenchyma. Complete absence of intestinal radioactivity may be an important diagnostic feature in the presence of an abnormal or negative pancreatic scan, reinforcing the suspicion of a pancreatic tumor. (auth)

791 ACCUMULATION AND STORAGE OF COMPOUNDS CONTAINING ^{99m}Tc SODIUM PERTECHNETATE IN IMPORTANT HUMAN ORGANS. Nohl, H. (Univ., Munich). Fortschr. Geb. Roentgenstr. Nuklearmed., 111: 414-19(Sept. 1969). (In German).

Determinations of the concentration of ^{99m}Tc in various organs, and total body measurements, were carried out after the administration of diagnostic quantities of this substance for brain scanning for various neurological abnormalities. Variations in the storage in different organs were observed and the storage mechanism in parenchymatous organs was described. Attention was drawn to the relatively high concentrations in the gonads. (auth)

792 ACTIVATION ANALYSIS OF MAN. Chamberlain, M. J. (Univ. of Birmingham, Eng.). New Sci., 43: 575-9 (Sept. 18, 1969).

Our knowledge of the chemical composition of the human body is stated to be extremely scanty. Neutron activation analysis has been used to measure the total amounts of calcium and sodium in patients suffering from metabolic bone disease. Many other applications seem likely in the future. (auth) (UK)

Radiotherapy

Refer also to abstracts 383, 597, 616, 715, 749, 824, 852, 853, 868, 886, 889–893, 896–898, 907, 909, 911, and 1972.

793 ABOLITION OF THYROID FUNCTION IN THE RAT BY THYROIDECTOMY AND RADIOIODIDE. Rudolph, H.; Schiemer, H.-G.; zum Winkel, K.; Schimmelpfennig, K. (Univ., Heidelberg). Fortschr. Geb. Roentgenstr. Nuklearmed., 110: 730-4(May 1969). (In German).

Thirteen male rats of the Wistar-breed were given a 0.34 μCi $Na^{131}I$/g body weight dose (or multiples thereof) intraperitoneally at four-week intervals beginning 4 weeks after thyroidectomy. A second group of 18 animals received the same treatment without thyroidectomy. The remaining thyroid tissue was examined histologically and radiologically. Only the thyroidectomized animals that received a single dose of 1.36 μCi ^{131}I/g body weight showed a complete elimination of all thyroid tissues. (tr-auth)

794 THYROID FUNCTION IN ENDEMIC GOITER. Heinze, H. G.; Beckebans, J.; Frey, K. W.; Pabst, H. W.; Richter, J.;

Schwarz, K.; Scriba, P. C. (Univ., Munich). Fortschr. Geb. Roentgenstr. Nuklearmed., 110: 717-29(May 1969). (In German).

Seven hundred and sixteen patients with goiters were investigated (diffuse and nodular goiters, including patients following resection or treatment with ^{131}I for benign goiters). These showed mean values of ^{127}I PB, of so-called free ^{125}I-T_3 and of free thyroid hormones, that were significantly lower than in normal patients (N = 48) and in patients with enlarged thyroid glands (N = 267). Increased ^{131}I deposition and accelerated ^{131}I metabolism in euthyroid iodine deficient goiters does not indicate increased thyroid function, since these patients had reduced thyroid hormone levels in the serum. Treatment or prophylaxis with thyroid hormones is not indicated in these patients. (tr-auth)

795 A CRITICAL REVIEW OF RADIATION THERAPY USING HYPERBARIC OXYGEN TREATMENT. Wideroee, R. (Brown, Boveri and Co., Ltd., Baden, Switzerland). Fortschr. Geb. Roentgenstr. Nuklearmed., 110: 738-44(May 1969).

The fundamentals of hyperbaric oxygen irradiation are described. The influence of oxygen concentration on the basic α- and β-effects is discussed. Methods and experience with hyperbaric oxygen treatment are described and evaluated critically. (tr-auth)

796 TUMOR TREATMENT WITH RADIOACTIVE WIRES. Meyerhoefer, H. (Zentralen Strahleninstitut, Nuernberg, Ger.). Fortschr. Geb. Roentgenstr. Nuklearmed., 110: 392-9(Mar. 1969). (In German).

Carcinomas of the vulva, lips, and oral cavity (as well as large cavernous hemangiomas) were treated by the introduction of radioactive wires. In order to calculate doses, tomographic cuts of the plane containing the wires were obtained. They show the wires as points and the isodoses can be marked concentrically around these. With the aid of this pin-point procedure, it is possible to calculate minimal doses in the area to be irradiated, as well as the dose received by critical areas in the neighborhood of the tumor. The method can be used as the sole form of treatment, or can be combined with telecobalt therapy for additional radiation of a tumor remnant, or of a particularly resistant tumor area. (auth)

797 INJURY TO THE BONE MARROW IN SIMULTANEOUS RADIO- AND CYTOSTATIC-THERAPY. Fuchs, G.; Hofbauer, J. (Kaiser-Franz-Josef-Spitals, Vienna). Radiol. Aust., 18: 233-8 (1968). (In German).

In the treatment of systemic diseases of blood forming tissues, a combination of cytostatics with x-ray therapy is the treatment of choice. Combination of generally effective chemotherapy with localized x-ray treatment requires good cooperation. Both treatments may impair the bone marrow yet damage by x-rays is of a localized nature. Close cooperation between chemotherapy and radiotherapy succeeds to overcome dangers and side effects. (auth)

798 LEVEL OF BASOPHILIC GRANULOCYTES IN BLOOD DURING THERAPY USING ^{131}I. Ferlin, G.; Mantero, F. (Univ., Padua). Acta Isotop., 8: 133-9(Oct. 30, 1968). (In Italian).

The level of the peripheral basophil cells in 23 hyperthyroid patients during treatment with ^{131}I showed a progressive increase toward normal as the condition of the patient improved. Statistically, it was shown that there is a good correlation between the level of basophils and the BMR. The same picture was seen in 45 untreated hyperthyroid subjects. These results confirm the diagnostic usefulness of the basophil count in thyroid diseases, and offer also a way to evaluate the efficiency of ^{131}I treatment in Basedow disease. (auth)

799 INITIAL EXPERIENCES WITH X IRRADIATION OF CHRONIC JOINT INFLAMMATIONS IN THE DOG. Hartung, K.; Clauss, W. (Freie Univ., Berlin). Berlin. Muench. Tieraerztl. Wochenschr., 80: 295-7(1967). (In German).

The mechanism of effect of x irradiation in doses of 450 to 600 R administered to inflamed arthritic joints of dogs was discussed. The various physicochemical and morphological events that were suggested to result from irradiation included an initial change in the acidotic state of the inflamed joint to a normal, alkaline condition. This was accompanied by destruction of very radiosensitive lymphocytes and histiocytes present in the tissue. Proteolytic enzymes that promoted cell breakdown and removal were activated. The capillaries in the tissue became expanded by the irradiation and the permeability of the vessel walls increased. Pain symptoms were relieved rapidly by effects on the autonomic nerve endings. Results of x irradiation of joints in five arthritic dogs showed marked diminution of pain and extensive recovery of freedom of movement. (BBB)

800 CLINICAL EFFECTS OF GLUTIDE, A PREPARATION OF GLUTATHIONE, ON RADIATION SICKNESS WITH SPECIAL REFERENCE TO THE GYNECOLOGICAL FIELD. Izumi, Hiroya (Hokkaido Univ., Sapporo). Sanfujinka No Sekai, 21: 423-5(Apr. 1969). (In Japanese).

Treatment of radiation sickness was attempted. The cause of radiation sickness is attributed to the fact that the biochemical reaction to radiation accelerates the appearance of peroxides and degenerates protein. Considering the strong oxidizing action of the SH base of glutathione (γ-L-glutamyl-L-cysteinyl-glycine) and the frequent disturbances of the liver function in cancer patients, Glutide injection, a preparation of glutathione, was used. The method of administration was as follows: Intramuscular injection of 100 mg of Glutide alone, slow intravenous injection of 100 mg of Glutide together with 20% glucose, and intravenous drip of 100 mg of Glutide. Symptomatic relief was marked in the treated group, compared with the control group. Subjective symptoms were observed in 55 cases. Improvement of symptoms was noted in 40 cases (72.7%); no improvement, in 11 cases (20.0%); and exacerbation, in 4 cases (7.3%). No particular side reaction was observed during the use of this drug. (M.M.B.)

801 UNUSUAL MANIFESTATIONS OF CARCINOMA OF THE NASOPHARYNX. Kaplan, Gustave; Rubenfeld, Sidney; Gordon, Richard B. (New York Univ., N. Y. Veterans Administration Hospital, New York). Cancer, 24: 781-5(Oct. 1969).

A case of carcinoma of the nasopharynx that occurred in a 21-year-old Negro man is reported. He developed metastasis in the left humerus that simulated a primary bone tumor. This was studied by biopsy, angiography, and a ^{85}Sr scan. He subsequently complained of pain in the right humerus. Angiography and ^{85}Sr scan revealed metastasis in the bone before x-ray verification. X-ray therapy induced prompt pain relief. (auth)

802 TREATMENT OF PULMONARY METASTATIC DISEASE WITH RADIATION THERAPY AND ADJUVANT ACTINOMYCIN D. Cupps, Roger E.; Ahmann, David L.; Soule, Edward H. (Mayo Clinic, Rochester, Minn. Mayo Foundation, Rochester, Minn.). Cancer, 24: 719-23(Oct. 1969).

The records of 46 Mayo Clinic patients who had received x-ray therapy to the lung, with adjuvant actinomycin D, as treatment for metastatic pulmonary disease were reviewed. The dates of the retrospective study were from January 1962 through April 1967. X-ray therapy was administered according to two schedules and directed through portals encompassing either a hemithorax or the entire chest. Thirty-six patients each received daily fractions six times a week, achieving a total dose of 1,500 Rads, as measured at the midplane of the thorax; the usual daily midplane dose was 100 Rads. The remaining 10 patients each received a total dose of 1,200 Rads in eight treatments to portals encompassing both lungs. Actinomycin D was given to all 46 patients by direct intravenous infusion. The usual dose was 5.1 μg/kg/day for an average of 12 days. Three significantly long regressions were obtained with this program of combined therapy: 51, 28, and 18 months. However, seven of the 18 patients in whom there was a response had lesions that would ordinarily be considered sensitive to radiation therapy alone. Because almost all of the patients experienced significant morbidity, this program cannot be recommended as routine treatment at the present time. (auth)

803 CLINICAL STUDIES ON STEREOTAXIC PROTON BEAM HYPOPHYSECTOMY BY THE KJELLBERG METHOD: ITS INDICATION IN ACROMEGALY. Shintani, Akira (Nagoya Univ., Japan); Kjellberg, Raymond N. No to Shinkei, 21: 57-67(Jan. 1969). (In Japanese).

The method of using the Bragg peak of a proton beam for hypophysectomy is described and its favorable effects on acromegaly, especially from the endocrinologic point of view, are reported. Twenty-two patients with acromegaly were irradiated, 14 of whom were followed for 2 to 36 months. In nine the size of hands, feet, and/or face decreased. Clinical findings were also improved to a variable extent, such as headache, fatigability, heat intolerance, joint pain, sexual hypofunction, weight gain, skin changes, tachycardia, hypertension, visual-field defects, disturbed glucose tolerance tests, abnormal thyroid function tests, and ketosteroid and hydroxysteroid excretion. In 12 cases reduction of growth hormone level was noted, although the degree of decrease was modest in four cases. The follow-up observations showed a gradual decrease in level of human growth hormone in blood, and demonstrated the necessity for longer data collection for the judgment of radiation effects. Proton irradiation in acromegalic patients was accompanied by no mortality, cerebrospinal fluid leakage, infection, or diabetes insipidus. Complications in this series included transient headache, diplopia, and one case of anterior pituitary insufficiency. One patient with blindness in one eye and focal brain ischemia that developed after irradiation was treated surgically. Special attention to the level of human growth hormone was given, especially

its change with the treatment and its correlation with clinical, endocrinologic, and physical parameters. It was emphasized that the measurement of human growth hormone is essential to a diagnosis of acromegaly and to an analysis of the effect of irradiation. (BBB)

804 HEPATIC LOBECTOMY IN CHILDHOOD: EFFECTS OF X-RAY AND CHEMOTHERAPY. Filler, Robert M.; Tefft, Melvin; Vawter, Gordon F.; Maddock, Charlotte; Mitus, Anna (Children's Hospital Medical Center, Boston). J. Pediat. Surg., 4: 31-41(Feb. 1969).

Study of the effects of ionizing irradiation and chemotherapy, in two children that underwent right hepatic lobectomy for localized liver metastases after nephrectomy for Wilm's tumor, revealed that the toxicity of x rays and actinomycin D is exaggerated after hepatectomy, and that these agents may be responsible for impaired liver regeneration. Postoperatively, one patient that was treated with actinomycin D (70 μg/Kg) and x irradiation (3068 rad to the left renal bed and 1264 rad to both lung fields at the rate of 1000 rad/week) made an uneventful recovery. Six months later a right hepatic lobectomy was performed for a solitary metastasis in the right lobe of the liver. At surgery, an internal lead shield was placed around the right kidney for temporary protection during the period of planned postoperative radiotherapy to the abdomen. Actinomycin D and irradiation were started on the day of surgery. Irradiation to the midplane of the abdomen (916 rad) and to the left upper quadrant of the abdomen (1356 rad) was delivered over 34 days. Major complications included early intraabdominal bleeding associated with thrombocytopenia (platelet counts below 60,000/mm^3); recurrent collections of blood, bile, and pus in the right subphrenic space; and late liver dysfunction. In the second case, during nephrectomy for Wilm's tumor, no metastases were noted. Postoperatively, the child received actinomycin D (70 μg/Kg) and x irradiation (3360 rad) to the left renal fossa. Three yr later, the patient developed a single metastatic focus in the right lobe of the liver. A right hepatic lobectomy was performed and actinomycin D along with irradiation to the abdomen and right chest was started; 600 rad was given to each location over the next 4 days. On the eighth day, a severe radiation reaction was noted in the skin at the sites of treatment. An erythematous maculopapular rash appeared, and severe leukopenia (below 1000/mm^3) and thrombocytopenia (below 50,000/mm^3) developed. Long-term postoperative evaluations in both cases revealed the development of severe chronic hepatic impairment due to inadequate liver regeneration and the effects of hepatic irradiation. Similar problems were not encountered in children with hepatic lesions treated only by hepatic lobectomy. In an experimental study, rats were subjected to 70% hepatectomy and treated immediately with actinomycin D and/or irradiation (350 R) to the liver. Death rates, body weight changes, and liver regeneration were compared to appropriate controls. Results confirmed that partial hepatectomy decreases tolerance to this drug and irradiation, that in turn limit liver regeneration. It is suggested that chemotherapy and irradiation be withheld following partial hepatectomy until liver regeneration is nearly complete. (BBB)

805 LONG-TERM DAMAGE TO THE PELVIC ORGANS FROM IRRADIATION OF UTERINE NEOPLASMS, ANATOMIC CONSIDERATIONS ON THE REPORTED CASE. Giunti, Giulio. Boll. Sci. Med. (Bologna), 139: 190-2(Apr.-June 1967). (In Italian).

The autopsy report of a woman who had received radiotherapy for uterine carcinoma and who died of rectal carcinoma was reported. The autopsy attempted to determine any possible relation between the uterine carcinoma, detected 16 years previously, and the rectal carcinoma and to determine any effect that the radiotherapy of the uterine carcinoma could have on the origin of the rectal carcinoma. The possibility that the rectal carcinoma was a case of secondary carcinomatose manifestations, that occur 8 to 10 yr after the primary manifestation, was considered. The possibility of a primitive autochthon origin of the rectal carcinoma was also discussed. Autopsy findings to support both hypotheses are reviewed. (J.S.R.)

806 ANATOMOHISTOLOGIC ASPECTS OF THE CARDIAC DAMAGE DUE TO IONIZING RADIATION. Menozzi, V.; Dusi, U.; Ferri, G. G. Riv. Anat. Patol. Oncol., 31: 90-7(Jan. 1967). (In Italian).

A case of villous pericarditis, occurring after x-ray therapy of a carcinoma of the left principal bronchus in a 45-year old man, was described. The clinical, anatomical, and histological elements made it possible to follow the injury resulting from the effects of the radiation. The possible effects on cardiac damage as a result of the radiotherapy were analyzed on the basis of literature data and on the basis of personal clinical and experimental work. (tr-auth)

807 GONAD DOSE AND GENETIC RISK IN ^{60}Co THERAPY. Fuchs, Georg; Hofbauer, Josef (Kaiser-Franz-Josef-Spital, Vienna). Strahlentherapie, 138: 178-80(Aug. 1969). (In German).

In telecobalt therapy of various parts of the body the gonad dose was measured. Generally the doses were lower than in other methods of radiotherapy. Among the patients of telecobalt therapy there were only few for which the gonad dose was genetically significant. (auth)

808 TIME-DOSE STUDY IN POST-OPERATIVE BREAST IRRADIATION FOUR TIMES VS FIVE TIMES WEEKLY FRACTIONATION. Green, J. P.; Vaeth, J. M.; Lowy, R. O. (Claire Zellerbach Saroni Tumor Inst., San Francisco. Mount Zion Hospital and Medical Center, San Francisco). Radiol. Clin. Biol., 38: 197-204(1969).

The Zellerbach Saroni Tumor Institute at Mount Zion Hospital and Medical Center has, for 8 years, followed a four-times-a-week treatment schedule. This schedule has brought about increased patient care and improved resident training, without observable increased normal tissue reactions. Based on radiobiologic observations, there may be increased tumor radiation response on such a fractionation schedule. A clinical study is described in which 21 patients were irradiated to identical total doses but on a four-times versus five-times weekly schedule to bilateral internal mammary fields. No significant difference in skin reactions between the two groups was clinically observed. (auth)

809 EFFECT OF FEVER DURING RADIATION THERAPY ON THE FIVE YEAR SURVIVAL TIME OF CERVIX CARCINOMA TREATED BETWEEN 1954 AND 1961. Weishaar, Julius; von Freyberg, Ingrid (Univ., Erlangen, Ger.). Strahlentherapie, 138: 323-7(Sept. 1969). (In German).

About half of the 817 patients, primarily treated by radiotherapy for a carcinoma of the uterine cervix between 1954 and 1961, and all staged I to III, showed a temperature increase above 38°C during the treatment. These patients had a 15% lower survival rate when compared to those who did not develop fever. The etiology of the fever could not be determined exactly in 69% of the cases. However in the majority of the cases (87%) a temporal relationship with the curietherapy was observed. The number of fever reactions decreased markedly from 1960, and any fever responded well to a one to two day treatment with broad-spectrum antibiotics. The prophylactic administration of antibiotics before the radium treatment should no longer be considered. (auth)

810 ANIMAL EXPERIMENTS CONCERNING RADIATION EFFECTS UNDER HYPERTHERMIA. Fochem, Kurt; Michalica, Werner; Picha, Engelbert (Univ., Vienna). Strahlentherapie, 138: 247-50(Aug. 1969). (In German).

Both normal and tumor bearing rats were exposed to 1200 R x radiation. To produce hyperthermia during radiation, one group was exposed to microwaves, while the other one received infrared light. Hyperthermia induced by microwave exposure slightly enhanced radiosensitivity; under infrared light radiosensitivity was increased strikingly. The previously observed higher efficiency of radiation was malignant tumors under hyperthermia can be explained by increased tolerance to radiation. (H.B.G.)

811 RADIOTHERAPY MOVES ON. Dawson, Kentish B. (Royal Marsden Hospital, Sutton, Eng.). New Sci., 42: 176-8(Apr. 24, 1969).

Fundamental studies in radiobiology are providing information that should help to place the radiotherapy of tumours on a more scientific footing. The aim is to maximize and localize the destructive force of the radiation beam, and to predict the response of tumours to irradiation. (auth)(UK)

812 EXTRACORPOREAL IRRADIATION FOR ACUTE LEUKEMIA. Chan, B. W. B.; Hayhoe, F. G. J. (Cambridge Univ., Eng.). Lancet, 2: 211-12(July 26, 1969).

The mechanism of action of extracorporeal irradiation (ECI) of the blood and antileukemic drugs in the treatment of leukemia is briefly discussed. Increased proliferative activity in the bone marrow of patients given ECI is described. When an antileukemic drug acts by inhibiting DNA synthesis, as with cytosine arabinoside, or by poisoning of the mitotic apparatus, as with vincristine, it acts on a greater number of leukemic than normal cells when the proportion of cells in DNA synthesis or at mitosis is increased. Such an increase of cells in DNA synthesis or mitosis may be brought about by ECI in some cases. In ECI a situation exists in which a part of leukemic tissue is selectively destroyed. It is suggested that this offers a unique opportunity to observe how leukemic marrow behaves under functional stress, and that marrow stimulation may form part of an overall therapeutic strategy. (BBB)

813 PHOTOGRAPHIC DOSIMETRY: CONSTRUCTION OF ISODOSE CURVES. Olivares, M. P.; Plata, A.; Perez-Modrego, S. (Asociacion Espanola Contra et Cancer, Madrid). Acta Oncol, 6: 18-27(Jan.-June 1967). (In Spanish).

The advantages of the use of wedge filters in the treatment of different tumorous localizations (larynx, bladder, etc.) have called for its inclusion into the Telecobaltotherapy Units. The problem of the experimental determination of isodose curves corresponding to the filtered irradiation beam is discussed. The Telecobaltotherapy Unit is made up as follows: printing of a photographic film by means of the filtered irradiation beam, introduced in a phantom equivalent to the human body; processing of the film in convenient conditions; determination of depth of the different isodoses corresponding to pre-fixed percentages through dose measurements taken with an ionization camera in the axis of the filtered beam; densitometric exploration of the irradiated photographic film; and construction of isodoses curves. This procedure permits the calibration of the Teletherapy Unit, utilizing a minimum time which represents a great advantage due to the working hours that a cobalt bomb generally is in operation in a hospital. (auth)

814 VIEWPOINTS ON WHOLE-BODY TELECOBALT IRRADIATION. Gauwerky, F.; Arnal, M. L. (Institut fuer Strahlentherapie, Hamburg). Radiol. Aust., 18: 171-9(1968). (In German).

The use of whole-body ^{60}Co γ radiation to treat 31 patients, most with chronic lymphatic leukemia (CLL), is described, with consideration of techniques and equipment used, dose estimations, hazards and complications, and clinical results. Partial-body ^{60}Co irradiation in 10 additional cases are described. A 6000-Ci source with a 275-cm focus-skin distance was used. How dosimetry was conducted with water-filled phantoms is explained. Patient thicknesses of 26 to 30 cm resulted in a fall-off of transit dose of 3.5 to 10%. Whole-body doses of 10, 15, or 20 R (at 7.5 R/min) every 2nd, 3rd, or 4th day were given until total doses of 150 to 250 R (and exceptionally 300 R) were reached. Treatment had only a palliative effect and only 2 of 10 patients with miscellaneous diagnoses survived more than 6 months. Longer survivals were obtained in several CLL cases. Several case histories are given in detail to show effects of treatment and changes in hematologic parameters. Whole-body irradiation appeared to be as effective as systemic treatment with ^{32}P. It is suggested that whole-body radiotherapy is especially useful in cases of bone marrow invasion by malignant cells. (BBB)

815 THE SURVIVAL OF PATIENTS WITH THYROID CANCER TREATED WITH RADIOIODINE: 147 CASES FOLLOWED UP FOR MORE THAN FIVE YEARS. Tubiana, M.; Perez, R.; Parmentier, C.; Monnier, J.-P. (Institut Gustave-Roussy, Villejuif, France). Presse Med., 76: 1999-2002(Nov. 2, 1968). (In French).

The results of treating thyroid cancer with ^{131}I are compared with those of postoperative transcutaneous radiotherapy with x rays and ^{60}Co γ rays. Complications of the treatment and avoidance of ^{131}I therapy where side-effects such as leukemia and genetic hazards may occur in young people are dealt with. The results obtained in the treatment of 147 cases of cancer of the thyroid by radioiodine are analyzed. Sixty-eight of these patients had no metastases when first treated, and in 12 the treatment was carried out routinely following an apparently successful operation. Ten survived for 5 yr, a result not much better than that obtained with surgery alone or surgery and transcutaneous radiotherapy (5-yr survival rate of 47 out of 50 patients). It does not seem justifiable at present to use radioiodine routinely, especially in young patients for whom this therapy has certain hazards. Among the 48 inoperable patients or those in whom surgical operation was incomplete, 18 survived for 5 yr, but at 10 yr there were only three survivors out of the 17 patients with differentiated carcinomas who were followed up for this period. Among the 79 patients with metastases when first treated, in 28 of whom the radioiodine was not taken up by the metastases, all died within 5 yr. Of the 51 cases in which the metastases took up radioiodine, the survival rates were 55% at 5 yr, 41% at 7 yr, 28% at 10 yr, and 22% at 12 yr. The results were better in cases with pulmonary metastases than bone metastases. The disappearance of all radiological signs and the absence of any radioiodine uptake more than 17 yr later in some patients raised the question of complete cure. (BBB)

Blast and Thermal Effects

816 (ABCC-TR-4-68) THYROID CARCINOMA IN ATOMIC BOMB SURVIVORS, HIROSHIMA AND NAGASAKI. Wood, James W.; Tamagaki, Hideya; Neriishi, Shotaro; Sato, Tatsuo; Sheldon, Warner F.; Archer, Philip G.; Hamilton, Howard B.; Johnson, Kenneth G. (Atomic Bomb Casualty Commission, Hiroshima, Nagasaki (Japan)). Jan. 25, 1968. 17p. (In English and Japanese). Dep. CFSTI.

Between 1 December 1963 and 31 December 1965, 39 patients who had had thyroid cancer were examined in the ABCC-JNIH Adult Health Study program. Twelve additional cases have been identified among sample members who were not examined during this period. The occurrence of thyroid cancer was higher in women than in men and showed a significant increase with the proximity of atomic bomb exposure and increase in estimated radiation dose received. However, when the subjects were less than 20 years at exposure the rates were the same for both sexes. Thyroid cancer in this sample did not pursue an aggressively malignant course. Sixteen persons died with thyroid cancer but in no instance could death be attributed to thyroid cancer, despite the unequivocal histologic findings of malignancy. (auth)

Radiation Effects on Animals

Refer also to abstracts 586, 603, 610, 614, 658, 662, 732, and 747.

817 (BNL-13979) FRACTIONATION RESPONSE OF G_1 CHINESE HAMSTER CELLS IN EXPONENTIAL GROWTH. Elkind, M. M.; Kano, E. (Brookhaven National Lab., Upton, N. Y.). [1968]. 10p. (CONF-690915-1). Dep. CFSTI.

From Proceedings on Time and Dose Relationships in Radiation Biology, Carmel, Calif.

Fractionation response of cells was examined in different phases of the growth cycle. Cells were synchronized by treatment with hydroxyurea and irradiated with 55 kV x rays at 722 rads/min. Immediately after the conditioning dose the survival curve of surviving cells was exponential and indicated no residual capacity for sublethal damage. Four and one-half hr later surviving cells developed an appreciable capacity for sublethal damage. It was concluded that sublethal damage was repaired in G_1. (H.L.W.)

818 (COO-119-240, pp 224-42) THE COMPARATIVE TOXICITY OF ^{226}Ra, ^{239}Pu, ^{228}Th, ^{228}Ra AND ^{90}Sr TO THE HEMATOPOIETIC SYSTEM OF BEAGLES FOR THE FIRST YEAR FOLLOWING INJECTION. Dougherty, J. H.; Rosenblatt, L. S. (Utah Univ., Salt Lake City. Radiobiology Div.).

The comparative toxicity of several internal emitters on blood leukocytes was studied in beagles for the first year post-injection. One of the following radionuclides: ^{226}Ra, ^{239}Pu, ^{228}Th, ^{228}Ra, or ^{90}Sr, was injected intravenously at six different injection levels into beagles approximately 1.4 years of age. The probit technique was utilized to linearly relate response to the logarithm of injected μCi/kg. The occurrence of a dose-dependent depression in leukocytes was previously established for these radionuclides. Probit analysis allows calculation of 50% leukocyte depression (ED50) and toxicity indices as well as RBE values for each radionuclide compared to ^{226}Ra as a standard. Alpha irradiation, particularly when deposited on bone surfaces, caused greater leukocyte depression than β irradiation. Blood neutrophils showed the greatest percent loss followed by monocytes and lymphocytes. (auth)

819 (ORNL-tr-2129) INVESTIGATIONS ON THE METABOLISM OF NUCLEIC ACIDS OF MONKEY KIDNEY TISSUE CELLS AFTER INFECTION WITH SV-40. III. STUDIES ON THE MECHANISM OF VIRUS-DETERMINED ENHANCEMENT OF DNA SYNTHESIS. Werchau, H.; Maass, G.; Westphal, H.; Haas, R. Translated for Oak Ridge National Lab., Tenn., from Arch. Gesam. Virusforsch., 21: 265-75(1967). 13p. Dep. CFSTI.

SV-40 infected monkey kidney tissue cultures (Cerc. aeth.) were labeled with 2-^{14}C-thymidine from the 72nd to the 74th hour after infection. At 74, 98, and 122 hours after infection all DNA was extracted from the cultures and investigated by zone centrifugation. No changes in the molecular size of the DNA extracted at the different times were detectable. X-irradiated monkey kidney tissue cultures synthesized as much SV-40 virus as non-irradiated cultures. In x-irradiated tissue cultures as well as in non-irradiated cultures the synthesis of a DNA of the cellular type was stimulated in addition to the synthesis of viral DNA. (auth)

820 INTERACTION BETWEEN ALLOGENEIC CELLS OF HUMAN ORIGIN: AN IN VITRO MODEL FOR GRAFT REJECTION. Moeller, G.; Lundgren, G.; Zukoski, Ch.; Beckman, Vera (Serafimerlasarettet, Stockholm). Scand. J. Urol. Nephrol., 1: 199-224(1967).

X irradiation and other suppressive agents were used to inhibit lymphoid-cell-mediated cytotoxicity. Monolayer cultures of human fibroblasts were damaged by contact with allogeneic lymphoid cells from nonimmune donors, whereas autochthonous lymphoid cells

were less efficient in this respect. In the presence of phytohemagglutinin (PHA) or streptolysin, lymphoid-cell-mediated killing of allogeneic targets was accelerated and could be detected after only 12 to 24 hr. Irradiation of the allogeneic lymphoid cells with 4000 R did not destroy their capacity to kill, but decreased the efficiency of cytotoxicity. Cortisone, Mitomycin C, azathioprine, and actinomycin C did not abolish lymphoid-cell-mediated cytotoxicity of allogeneic target fibroblasts. Irradiation reduced the number of surviving PHA-treated lymphoid cells markedly, indicating that irradiation affected the kinetics and strength of plaque formation by reducing the number of surviving cells, rather than having an effect on some functions of the lymphoid cells themselves, in particular as the dose used was much larger than that required to suppress homograft reactivity completely in the intact animal. (BBB)

821 ELECTRON MICROSCOPIC STUDY ON INFLUENCE OF CARCINOSTATIC SUBSTANCES OF HELA CELLS. PART 2. THE INFLUENCE OF 5-FU (5-FLUOROURACIL). Kato, Sumihiko; Fujimoto, Michimasa (Tokushima Univ., Japan). Jibi Inkoka Rinsho, 62: 450-3(Apr. 1969). (In Japanese).

The influence of 5-fluorouracil (5 FU) on HeLa-cells was studied with an electron microscope. The results obtained are as follows: In HeLa-cells cultivated in the presence of 2.5 mg/ml of 5-FU condensation of nucleoli and swelling of mitochondria were observed after 30 minutes. Vacuole formation within the cytoplasm and rupture of limiting membranes around the vacuoles were found after 8 hr and later. When the HeLa-cells were exposed to 5 mg/ml of 5 FU for 10 minutes, no change in HeLa-cells was observed immediately after the exposure, but after 24 hr, the above-mentioned changes were found in some of the HeLa-cells. Therefore, it is thought that 5-FU has an indirect action as well as a direct one. Secondly the HeLa-cells with or without 5 FU (2.5 mg/ml) treatment were irradiated by ^{60}Co γ rays, and the change in HeLa-cells was studied with an electron microscope. The results obtained are as follows; In the HeLa-cells subjected to only ^{60}Co irradiation, scarcely any change was found immediately after the irradiation, but after 24 hr, blurring of reticular structures of nucleoli, swelling mitochondria, and vacuole formation were observed. In the HeLa-cells subjected to ^{60}Co irradiation after 5-FU-treatment, condensation of nucleoli and swelling of mitochondria were found even immediately after the irradiation, and after 24 hr, division, rupture or condensation of nucleoli, swelling of mitochondria, destruction of mitochondrial crests, vacuole formation, and rupture of membranous structures were observed. (NSA of Japan)

822 CHEMICAL FILTERS FOR NARROW BAND UV IRRADIATION BETWEEN 235 AND 200 nm. Muel, B.; Malpiece, C. Photochem. Photobiol., 10: 283-91(Oct. 1969).

Six chemical filters were described namely: nickel sulfate and cobalt sulfate solution, cyanine, acetone in a mixture of water and ethanol anisole in 95% ethanol, anthracene in cyclohexone, chloroform in 95% ethanol and combined with perchlorate of cyanine, and carbon tetrachloride in cyclohexane combined with cyanine. Bands of 10 to 20 nm half width were isolated at the following wavelengths: 235, 240, 252, 260, 277 and 294 nm. The filters transmitted at the center of their band passed between 1.5 and 30% of the incident radiation. Average photon fluence rates of 15 to 150 ergs nm^{-2} sec^{-1} (0.3×10^{-3} to 3.5×10^{-3} μE cm^{-2} sec^{-1}) were obtained with a 500 W high pressure mercury arc focussed on a 10 cm^2 area. Under these conditions, the flux transmitted in the near ir, visible, and near uv did not exceed 1% of the total flux transmitted. The flux transmitted outside a 40 nm band centered at the maximum did not exceed 1% of the total transmitted flux for four of the filters, this flux went up to 4% of the total for the 294 nm filter and to 10% for the 235 nm filter. (UK)

823 LASER RADIATION IN BIOLOGY. Squassabia, Antonio Bruno (Univ., Pavia, Italy). Recenti Progr. Med., 42: 465-89(May 1967). (In Italian).

The laser is described in some detail with a discussion of the physical principles, technological principles, types of lasers, characteristics of laser radiation, and dosimetry of laser radiation. The mechanism of laser action at the biological level is described with respect to the effects generated by the passage of a laser beam through a biological system, physical phenomena, elective absorption of a specific wavelength by particular cellular constituents, phenomena of an immune nature, and the presence of free radicals. The laser action on macromolecular preparations and enzymes is briefly considered. The effects on cells in culture, batteries of a non-microfocalized laser radiation, and laser radiation microscopically focused on a single cell in culture are also discussed. (J.S.R.)

824 EXTRACORPOREAL X-IRRADIATION AND REINFUSION OF BLOOD IN PATIENTS WITH CERVIX CARCINOMA. Fochem, Kurt; Michalica, Werner; Picha, Engelbert; Simanyi, Margarete (Univ., Vienna). Strahlentherapie, 138: 328-31 (Sept. 1969). (In German).

After preliminary tests on the blood quantity and the radiation dose, 450 cm^3 of blood in plastic bottles from 24 patients with a carcinoma of the uterine cervix was withdrawn. The blood was retransfused after an irradiation of 2400 to 4800 R. The patients were divided in four groups according to the radiation dose administered. The tolerance was good in all cases. Sedimentation rate was not affected, and blood formula was normal after irradiation, except for four cases with eosinophilie. Slight modifications were observed in the gamma-globulins: increase after low dose but decrease after high doses. The activity of malic dehydrogenase was strongly reduced the first day after transfusion, but becomes normal after four days. (auth)

825 COMBINED EFFECT OF IONIZING RADIATION AND BLASTOMOGENIC AGENTS. Kondrat'eva, A. F. Vop. Onkol., 15: No. 3, 109-18(1969). (In Russian).

A review of a series of studies shows that the combined action of blastomogenic agents of different types can incite the modification of carcinogenic effects. However, the differences of methodology in the experiments and their insufficient quantity do not permit any general conclusions to be made concerning additive or potentiating effects on carcinogenic action of ionizing radiation and chemical blastomogenic substances. At the same time, the results of experiments on the combined action of both factors demonstrated a weakening of blastomogenesis, but inadequacies in the methods used did not permit observation of an additive effect. Understanding of the mechanisms of the combined effects of the two agents is essential both for the development of our understanding concerning the mechanisms of the action of blastomogenic agents of different types and for the development of social-hygienic measures of prophylaxis of malignant neoplasm. (tr-auth)

826 EFFECTS OF FRACTIONATED IRRADIATION (3 X 200 R) ON THE PHAGOCYTIC FUNCTION OF THE RES IN RATS. Antonijevic, Milos (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Strahlentherapie, 138: 378-84(Sept. 1969).

The effect of single and fractionated irradiation on the phagocytic function of the RES in rats was studied using the carbon clearance test. Groups of animals were exposed to single dose of 600 R and to 3 × 200 R spaced at 10-day time intervals between each fraction. A dose of 200 R increased the global phagocytic index; subsequent fractions showed a tendency toward decrease what was particularly expressed following the third fraction. Comparison of the phagocytic activity of rats receiving a single dose of 600 R and those having received the same dose in three fractions revealed difference in the acute postradiation period: The phagocytic activity was increased after single dose of 600 R but it was at the level of controls with a tendency to decreasing after an accumulated dose of 600 R. In the postacute period of examination (up to 4 months) an increase in the phagocytic activity was observed regardless if the rats were exposed to single or fractionated irradiation. (auth)

Invertebrates

Refer also to abstracts 651, 659, 666, 667, 690, 757, 932, and 935.

827 (RLO-2047-5, App. C) EFFECTS OF TRITIUM, ^{90}Y, AND ^{90}Sr +^{90}Y ON THE LARVAE OF THE PACIFIC OYSTER, CRASSOSTREA GIGAS. (Washington Univ., Seattle. Lab. of Radiation Ecology). 4p.

Larvae of the Pacific oyster, Crassostrea gigas were exposed to ^{90}Y, ^{90}Sr, and tritium and the concentration determined that impaired development within 48 hr. The threshold concentration of the three radionuclides was approximately the same, 10^{-3} Ci/l of seawater; however, the radiation dose emitted by tritium apparently was lower, probably caused by the difficulty in measuring absorbed doses. (H.B.G.)

828 (RLO-2047-5, App. D) ESTIMATION OF BIOLOGICAL HALF-LIFE FOR ZINC IN OYSTERS. (Washington Univ., Seattle. Lab. of Radiation Ecology). 2p.

Oysters were exposed to ^{65}Zn and measured in a whole-body counter. Following incorporation of the ^{65}Zn, the animals were returned to their natural habitat and remeasured in monthly intervals. Thus far, over a period of three months, the loss of ^{65}Zn activity was not much greater than that expected by physical decay. (H.B.G.)

829 MUTATIONAL RESPONSES OF INSECTS IN THE BIOSATELLITE II EXPERIMENT. von Borstel, R. C. (Oak Ridge National Lab., Tenn.); Smith, Roger H.; Whiting, A. R.; Grosch, D. S.; Oster, Irwin I.; Slater, John V.; Buckhold, Brenda,

pp 70-6 of Life Sciences and Space Research VII. Vishniac, W.; Favorite, F. G. (eds.). Amsterdam, North-Holland Publishing Co., 1969.

From 11th Plenary Meeting, Tokyo, Japan. See CONF-680530-(Vol.7); From Symposium on Biological Effects of Radiation in Space, Tokyo, Japan. See CONF-680555.

Genetic effects associated with space flight include mutation induction by the space flight itself, and enhancements or antagonisms of radiation-induced mutations. The conditions of space flight vary in mutagenic effectiveness from no response at all to responses nine times that found in ground-based controls. The test systems follow the sensitivity pattern: spermatogonial translocations > oogonial and oocyte nondisjunction > recessive lethality of stages in spermatogenesis > dominant lethality of stages in spermatogenesis. Large enhancing and antagonistic effects of space flight in conjunction with radiation were observed in the Biosatellite II experiment. The most surprising one was the elimination of the effect of 2500 R by space flight in Habrobracon oogonia where the effects of 500 R normally can be easily observed. Two sets of parameters are considered in attempts to explain the responses: the nature of the biological targets, and the particular conditions of space flight that are responsible for the effects. (auth)

830 BIOSATELLITE II: PHYSIOLOGICAL AND SOMATIC EFFECTS ON INSECTS. Buckhold, Brenda (Univ. of California, Berkeley). pp 77-83 of Life Sciences and Space Research VII. Vishniac, W.; Favorite, F. G. (eds.). Amsterdam, North-Holland Publishing Co., 1969.

From 11th Plenary Meeting, Tokyo, Japan. See CONF-680530-(Vol.7); From Symposium on Biological Effects of Radiation in Space, Tokyo, Japan. See CONF-680555.

Interesting physiological and somatic effects of space flight have been observed in a variety of insects on board Biosatellite II. Wasps, beetles and fruit flies have demonstrated positive effects of the space flight alone or in combination with irradiation. In the flour beetle, Tribolium confusum, the incidence of a developmental wing abnormality was measured. This abnormality, which mimics the mutation known as "split," was significantly increased in beetles that were flown as young pupae, pre-irradiated with x-rays to bring them into their sensitive dose range and γ irradiated during flight. Wing abnormalities increased from a ground value of 29.9 per cent to a value of 44.8 per cent. The length of the pupal period was also measured. Although there was a significant increase of the flight pupal period over that of the ground control, the most likely explanation seems to be the temperature drop of the flight samples between separation and retrieval of the flight capsule. In the parasitic wasp, Habrobracon juglandis, flown in the adult stage, several interesting results have been obtained in terms of reproductive performance, life span, and enzyme activity. Reproductive performance, measured by the average number of eggs laid/female/day, was unaffected by flight for control unirradiated wasps. However, for females x-rayed with 2000 R prior to flight, the characteristic depression of egg-laying at 10 days post-irradiation was negligible in the flight animals. A more pronounced effect was observed in those females that received the chronic 2667 R γ ray dose in flight; egg production actually progressively increased to twice the level of the ground sample. It was observed that males were disoriented in their mating behavior for 2 days after the flight. When the dose level data were pooled, the life span of females was found to be significantly longer in the flight group. Upon analysis of the activity of the enzyme, xanthine dehydrogenase (XDH), adult flight males were found to have a significantly decreased XDH activity compared with ground controls. No significant difference was found between female F_1 progeny of flight and ground males. XDH activity was also analyzed in F_1 progeny of Drosophila melanogaster, orbited as adults and larvae. For the F_1 male progeny of adult males, there was a significantly depressed average XDH activity compared with ground controls for the highest irradiation dose. For F_1 male progeny of flight larvae, there was a statistical decrease of XDH activity only between the off-spring of irradiated flight and ground larvae. Further somatic changes were observed in Drosophila larvae, in which chromosome aberrations were studied. (auth)

831 DEVELOPMENT OF TRANSPLANTED IMAGINAL DISKS IN X-IRRADIATED HOUSEFLY PUPAE. Bhaskaran, G.; Sivasubramanian, P. (Bhabha Atomic Research Centre, Trombay, India). Nature (London), 222: 786-7(May 24, 1969).

Transplantation and parabiotic experiments showed that, in irradiated vertebrate embryos, direct damage to organ rudiments is primarily responsible for development of abnormalities, and although the irradiated environment by itself does not adversely influence the development of normal organ transplants, it does appear to enhance the damage in irradiated organ rudiments. Some studies with housefly pupae are described in which it was observed that normal imaginal disks transplanted in irradiated pupae developed poorly. The epidermis of the irradiated host also inhibited the development of transplants when in contact. Experiments were carried out to find whether transplantation of the disks immediately after irradiation into nonirradiated hosts of the same age would reduce the effects of radiation damage, and whether an irradiated host environment had any influence on the development of nonirradiated transplants. Irradiation was with 2,000 R of x-rays at 400 R/min. Results are reported based on leg disk transplants as judged by the state of differentiation of the cuticular structures. The irradiated disks did not benefit by transposition into a nonirradiated environment, thus indicating that direct damage to the organ rudiments was solely responsible for abnormal development of the disks. A detrimental influence of the irradiated environment on differentiation of the transplanted organ rudiments was, however, clearly demonstrated. From the experiments it also appeared that some factors either in the haemolymph or in the fat body, which are normally required for development of the transplant, are totally destroyed by whole-body irradiation. The existence of a different type of indirect effect of irradiation was observed in experimental surface transplantation of the imaginal disks. Normal disks transplanted on the epidermis of whole-body irradiated hosts failed to differentiate, but irradiated disks transplanted on nonirradiated hosts developed to the same extent as in the legs of the donor pupae. It was obvious that, in surface transplants, development of the disks was profoundly altered by contact with irradiated host epidermis. (auth) (UK)

832 EXPERIMENTAL MORPHOGENESIS IN THE CILIATES: EFFECTS OF UV-IRRADIATION IN THE DIFFERENTIATION OF THE CILIA OF PARAMECIUM AURELIA. De Haller, G. (Univ., Geneva). Rev. Suisse Zool., 75: 583-8 (Sept. 1968). (In French).

Following uv irradiation of Paramecium aurelia cultures with a Westinghouse type G15T8 germicidal lamp, 94% of the organisms in the culture were killed. The surviving organisms were isolated and after 15 cell divisions the cells were fixed in osmic acid and treated with uranyl acetate. Sections were made and examined by electron microscopy. The kinetosomes and associated structures appeared normal, but the cilia were malformed. The typical 9 + 2 arrangement of the ciliary fibers was absent. The cilia were swollen and the peribasal vesicles were absent. The question as to whether the radiation has a mutagenic effect or acts directly on the cell cortex is discussed. (H.L.W.)

833 THE INFLUENCE OF TEMPERATURE, X IRRADIATION, AND CENTRIFUGATION ON THE SEX OF THE STICK INSECT CARAUSIUS MOROSUS Br. Pijnacker, J. P. Neth. J. Zool., 19: 282-3(June 1969).

Carausius morosus reproduces by thelytokous parthenogenesis, but a few sexually nonfunctional males (<0.5%) and gynandromorphs and intersexes (<2%) always emerge, even when the insects are bred at normal temperatures of 16 to 22°C. Higher percentages of males were found after x irradiation of primordial and oogonial cells, and of gynandromorphs after x irradiation of embryos during the first quarter of their development. Males and gynandromorphs could also be induced by centrifugation of eggs with embryonic development up to the germ anlage, as well as by x irradiation of oocytes in the first meiotic prophase or metaphase. Males arose through elimination of one sex chromosome before germ anlage development, and gynandromorphs through somatic elimination of one sex chromosome. Intersexes could be induced by both short and long incubation of eggs at higher temperature during the third stage of embryonic development. In these cases the development is modified in the male direction, without a change in the sex chromosome constitution. (BBB)

834 STUDIES ON THE METABOLISM OF TETRAHYMENA PYRIFORMIS GL. IV. IRRADIATION EFFECT ON CELL PERMEABILITY. Van de Vijver, G. (State Univ., Ghent). Enzymologia, 36: 371-4(June 30, 1969).

The influence of ^{60}Co γ irradiation on cell permeability of the protozoan Tetrahymena pyriformis, strain GL, was studied. The average dose rate was 470.4 kR/hr, and high doses (0.4 to 0.5 MR) were delivered. To determine changes in cell permeability, three dyes were used: methylene blue and neutral red that stain the vacuome and janus green staining the chondriome. Microscopic examination immediately after exposure revealed that more unirradiated control cells took up the dye and were more intensely colored than irradiated cells, indicating altered cell permeability caused by γ rays. Colorimetric measurements afforded an even clearer indication of this. These measurements were made on dye concentrations in the diluted supernatant solutions. Thus it was found that the initial dye solution was more diluted by the unirradiated ciliates than by the irradiated ones. The same tendency was seen with cells suspended in tap water in presence of the dyes. Control cells absorbed from the medium more dye than ex-

posed cells, indicating decreased cell permeability after exposure. (BBB)

Vertebrates

Refer also to abstracts 549, 556, 573, 580, 582, 583, 595, 599, 601, 604–608, 616–618, 620, 621, 623, 625–628, 630–643, 646, 648, 653, 656, 665, 674, 676, 742–745, 748–754, 756, and 810.

835 (AD-689098) PLATELET ADHESIVENESS FOLLOWING WHOLE-BODY X IRRADIATION. Kagnoff, M. F. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). May 1969. 21p. (AFRRI-TN-69-5). CFSTI.

Four male beagle dogs received 150 Rads whole-body x irradiation (WBR). Subsequent determinations of platelet to glass adhesiveness, platelet count, white blood cell count, and hematocrit were made. Platelet adhesiveness showed a significant decrease in all subjects after exposure. The maximum decrease was noted on the 11th day with recovery to preirradiation levels completed by day 35. Platelet count, white blood cell count, and hematocrit showed the usual characteristic changes postirradiation. The contribution of this qualitative change in platelet behavior to the hemorrhagic diathesis following WBR requires further investigation. (auth)

836 (COO-119-240) RESEARCH IN RADIOBIOLOGY. Annual Report of Work in Progress in the Internal Irradiation Program. Dougherty, Thomas F. (Utah Univ., Salt Lake City. Radiobiology Div.). Mar. 31, 1969. Contract AT(11-1)-119. 279p. Dep. CFSTI.

Ten separate papers were abstracted that deal with internal radiation effects in beagle dogs. Various radioisotopes were investigated and different methods of biological analysis reported. (H.B.G.)

For abstracts of individual papers see: 542, 551–555, 705, 818, 837, and 838.

837 (COO-119-240, pp 86-96) BONE CANCER INDUCED BY INTERNALLY-DEPOSITED EMITTERS IN BEAGLES. Dougherty, Thomas F.; Mays, Charles W. (Utah Univ., Salt Lake City. Radiobiology Div.).

Osteosarcomas were the chief cause of death in adult beagles injected intravenously with bone-seeking radionuclides in citrate solution. The effectiveness of each nuclide depends on the type of radiation emitted and where this radiation is absorbed. Alpha-radiation is more effective than β-radiation, and the α-emitters that deposit on bone surfaces are more effective than those that deposit throughout bone volume. For death with osteosarcomas 8 yr after injection, values for RBE (relative biological effectiveness) based on average skeletal dose at 1 yr before death and relative to $^{226}Ra = 1$ are: $^{239}Pu = 6$; $^{228}Th = 8$; ^{228}Ra (MsTh) = 2.5; and $^{90}Sr = 0.07$ to 0.24. (auth)

838 (COO-119-240, pp 262-74) SPECULATIONS ON THE RISK TO ADULT MAN FROM A "PERMISSIBLE" BODY BURDEN OF ^{239}Pu (0.04 μCi) EQUALLY DIVIDED BETWEEN BONE AND LIVER. Mays, Charles W.; Taylor, Glenn N.; Jee, Webster S. S.; Dougherty, Thomas F. (Utah Univ., Salt Lake City. Radiobiology Div.).

Beagles were injected intravenously with ^{239}Pu in citrate solution. The average concentrations to the beagle liver remained roughly the same for injections up to 0.3 μCi/kg. Since all liver tumors occurred below this level, the liver doses were assumed equal to the calculated skeletal doses. The threshold model was based on observations of radium-containing humans, whereas the dose rate and dose models were extrapolated from results in plutonium-containing dogs. (H.B.G.)

839 THE INFLUENCE OF CORTICOSTEROIDS AND ROENTGEN RAYS ON THE GROWTH OF REPLANTED HARDING-PASSY MELANOMA. Grigor'yan, V. L. (Inst. of Experimental and Clinical Oncology, Moscow). Byull. Eksp. Biol. Med., 67: No. 5, 64-6(May 1969). (In Russian).

Hydrocortisone and prednisolone produced a significant inhibitory effect (two to three times) on the growth of melanomas. The combined effect of hydrocortisone and x irradiation produced no summation of these two factors. The combined effect of prednisolone and x irradiation produced a more marked effect on the inhibition of tumor growth than either of these agents alone. However, full summation was not recorded. (auth)

840 ATTEMPT TO INFLUENCE ERYTHROPOIESIS OF NORMAL AND IRRADIATED RATS. Travnicek, Tomas; Neuwirt, Jan (Karlovy Univ., Prague). Acta Univ. Carolinae, Med., Monogr. No. 34, 219(1968).

Attempts were made to stimulate erythropoiesis in whole-body irradiated rats. Male Wistar rats were irradiated with doses of 25, 100, 400, 800, and 1000 R, and were killed two, four, or seven days after irradiation. Incorporation of ^{59}Fe into erythrocytes and ^{59}Fe utilization showed a significant dependence on the radiation dose. It was found that to study the effect of various agents on the speed and intensity of regeneration of radiation-damaged erythropoiesis in rats a dose of 600 R is the most suitable. Determination of hematologic parameters and incorporation of ^{59}Fe per 100 mg spleen tissue is advantageous in evaluating effects of the agents. Injection of hemolysate of autologous cells enhanced regeneration of erythropoiesis after blood loss in nonirradiated as well as in irradiated animals. Administration of hemolysate of homologous red blood cells had a stimulating effect in the first stages but by the 14th day the results were unfavorable. This was explained by an immunobiologic reaction. Administration of hydrocortisone and Superanabolon was without effect. Hydrocortisone decreased the weight of irradiated rats. The favorable influence of substances affecting maturation of elements of the red cell line in the marrow was demonstrated especially in irradiated rats subjected to blood loss and given an hemolysate of their own red cells. A combination treatment was developed to stimulate erythropoiesis in irradiated rats. This complex consisted of vitamin B_{12}, tetrahydrofolic acid, vitamin C, penicillin, and streptomycin. After a dose of 800 R administration of vitamin B_{12} and tetrahydrofolic acid had a favorable effect on hematologic values on the 14th day of the experiment. Administration of the combination of these substances with vitamin C and antibiotics improved survival of irradiated animals. Erythropoietic stimuli, such as a small loss of blood or hypoxia lasting for three days and the combination of these two stimuli, had a stimulating effect on regeneration of erythropoiesis in irradiated rats, especially when hemolysate of homologous red cells and the combination of drugs were administered simultaneously. A beneficial effect of this complex was seen even after doses of 700 and 800 R. The most favorable effect on hematologic values was found in rats in which erythropoiesis had been stimulated by a small blood loss or three-day hypoxia and which were given a hemolysate of their own red blood cells, vitamin B_{12}, tetrahydrofolic acid, vitamin C, and antibiotics. (BBB)

841 EFFECT OF LASER RADIATIONS ON THE EXPOSED CEREBRUM OF EXPERIMENTAL ANIMALS. Jaenisch, W.; Altrock, H.; Dietz, W. (Pathologisches Institut der Medizinischen Akademie, Erfurt, Ger.). Zentralbl. Allgem. Pathol. Pathol. Anat., 110: 458-64(1967). (In German).

The effects of laser irradiation with energy outputs of 9 and 140 Wsec/cm^2 on exposed cerebrums of mice and rats were studied after periods of 24 hr to 14 days following exposure to from 5 to 20 single pulses. Experimental conditions and factors that affected the laser beam were described. The irradiated brain tissues were examined macroscopically and microscopically. Hemorrhages, necroses, and edema were found in various amounts, and did not exceed 3 mm dia in any case. Glial resections included increased size and proliferation of astrocytes in regions of necrosis. The numbers of extensive hemorrhages, necroses, and the edema decreased rapidly after the first few days. Proliferation of mesenchymal cells and some infiltration of leukocytes and lymphocytes were observed. Morphological changes were essentially limited to the laser beam target area. There was no indication of functional injury of very large portions of the brain. The possible mechanisms of effect of laser irradiation on tissues that were discussed included heat production with protein coagulation, rupture of tissues and blood vessels by expansion of vaporized tissue fluids, absorption of particular laser wavelengths and damage to cell constituents, development of strong magnetic fields in areas irradiated with laser beams, and induction of ultrasonic waves. (BBB)

842 RETICULAR NEOPLASMS IN IRRADIATED AND UNIRRADIATED GERMFREE MICE. Walburg, H. E. Jr.; Cosgrove, G. E. (Oak Ridge National Lab., Tenn.). pp 135-41 of Germ-Free Biology. Experimental and Clinical Aspects. Mirand, Edwin A.; Back, Nathan (eds.). New York, Plenum Press, 1969.

From Symposium on Gnotobiology, Buffalo, N. Y. See CONF-680659.

Three groups of germfree and conventional mice were x-irradiated. Tables are presented to show effects of radiation on incidence of reticular neoplasms in both groups of mice, and a graph is presented to show the influence of germfree environment on cumulative incidence of reticular neoplasms observed at necropsy. Radiation induced the development of myeloid leukemia in mice reared in the conventional microbial environment, but failed to induce the disease in germfree mice. There was a higher incidence of lymphoma in germfree mice than in conventional mice. The incidence of reticulum-cell sarcoma was reduced in all irradiated groups. It is suggested that the increased incidence of reticulum-cell sarcoma in conventional mice may be related to

an increased antigenic stimulation of reticular cells in these mice. (H.L.W.)

843 7,12-DIMETHYLBENZ(α)ANTHRACENE-INDUCED MALIGNANT LYMPHOMA IN GERMFREE MICE. Kajima, Masahiro (Univ. of Notre Dame, Ind.). pp 153-61 of Germ-Free Biology. Experimental and Clinical Aspects. Mirand, Edwin A.; Back, Nathan (eds.). New York, Plenum Press, 1969.

From Symposium on Gnotobiology, Buffalo, N. Y. See CONF-680659.

Response of germfree Swiss–Webster mice to subcutaneous injection of 7,12-Dimethylbenz(α)anthracene (DMBA) in sesame oil at neonatal age was investigated. The results can be summarized as follows: Five out of eight mice that survived toxic death developed malignant lymphoma and in one case local sarcoma was observed. No neoplastic changes were found in control mice that were inoculated with sesame oil; Neoplastic response of germfree mice to DMBA-inoculation were similar in many aspects (incidence, latent period, gross finding, and histological examination) to that described by others in conventional mice similarly treated; Tumor virus (presumably leukemia virus) was found by electron microscopy in neoplastic tissues induced by DMBA and in normal tissues of control mice; and it can be assumed that high incidence of malignant lymphoma that developed only in mice not in other rodents similarly treated with DMBA could be attributed to the presence of leukemia virus widely present in laboratory mice. (auth)

844 POST-METAMORPHIC DEVELOPMENT OF THE GONADS AND BIDDER ORGANS IN YOUNG BUFO BUFO PAN-IRRADIATED WITH X RAYS. Di Grande, Foscarina (Univ., Bologna). Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 437-42(Nov. 1968). (In Italian).

Young tadpoles of Bufo bufo, with genital ridges filled with primordial germ cells at the beginning of mitotic proliferation, were subjected to 400 R x-ray panirradiation and were cultured, for the histological examination, until 25 days after the end of metamorphosis. At this developmental stage, their Bidder organs always showed several residual germ cells, which had normally reached bidderian oogenesis. Their gonads, on the contrary, often appeared completely lacking in germ cells. However, in the cortical and medullary somatic tissues of these sterile gonads the sex differentiation had normally occurred and, as a consequence, the female or male sterile gonads appeared quite differently organized. A precocious destruction of germ cells does not therefore modify the somatic sex differentiation of the gonads. (auth)

845 LESSENING OF GUINEA PIG ECZEMA BY A PREVIOUS X IRRADIATION. Maggiora, A.; Bujard, E.; Jadassohn, W. (Univ., Geneva). Dermatol. Wochenschr., 153: 601-4(May 27, 1967). (In German).

Effects of x irradiation with doses of 1600 R on production of eczematous reactions of guinea pig skin by dinitrochlorobenzene (DNCB) 3 to 5 months after irradiation were studied. Following sensitization to DNCB 60 days after irradiation, eczematous reactions were observed from 100 to 145 days after irradiation, although the skin then was almost completely acanthotic and normal in appearance. This indicated that lack of ability to react to DNCB was not directly related to presence of acanthosis, and that irradiation effects were detectable by this procedure after 100 to 145 days, even though they were not histologically apparent. Similar effects have been reported for estrogen-treated guinea pig tests 40 days after x irradiation with doses of 800 R when mitotic activity had been blocked with colchicine. (BBB)

846 CHARACTERISTICS OF BIOLOGICAL EFFECTS OF COSMIC RADIATION, MODEL INVESTIGATIONS. Parin, V. V.; Grigorev, Yu. G.; Kovalev, E. E.; Ryzhov, N. I.; Derbeneva, N. N.; Popov, V. I.; Petrovnin, M. G. pp 160-70 of Life Sciences and Space Research VII. Vishniac, W.; Favorite, F. G. (eds.). Amsterdam, North-Holland Publishing Co., 1969.

From 11th Plenary Meeting, Tokyo, Japan. See CONF-680530–(Vol.7); From Symposium on Biological Effects of Radiation in Space, Tokyo, Japan. See CONF-680555.

In view of the probability of the influence of ionizing radiation on crewmen and the appropriate problem of creating adequate antiradiation protection, it is necessary to investigate the peculiarities of biological effects of cosmic radiation. Under actual space flight conditions, cosmic radiation will affect the human organism in the complex along with other factors. Full imitation of cosmic radiation on the ground is impossible but it can exert influence on the human radiosensibility. In this connection, the successful solution of the problem of obtaining appropriate information can be made by a reasonable combination of both ground radiobiological and medical-hygienic investigations and those carried out by using artificial earth satellites. The available experience in carrying out such research and its results are given in this report. Information on investigating the peculiarities of biological effects of protons in the wide spectrum of energy is also included. The report contains the data of observing immediate and later effects of radiation influence on higher animals and also on many biological objects arranged in various levels of evolution and biological organizations. The values of the RBE for protons are given. (auth)

847 VESTIBULAR ANALYZER AS A CRITICAL ORGAN IN THE EVALUATION OF RADIATION HAZARDS DURING SPACE FLIGHTS. Grigorev, Yu. G. pp 173-85 of Life Sciences and Space Research VII. Vishniac, W.; Favorite, F. G. (eds.). Amsterdam, North-Holland Publishing Co., 1969.

From 11th Plenary Meeting, Tokyo, Japan. See CONF-680530–(Vol.7); From Symposium on Biological Effects of Radiation in Space, Tokyo, Japan. See CONF-680555.

During space flights the vestibular analyzer functions under conditions that are not usual for Earth environments. The vestibular analyzer periodically or constantly experiences the action of angular, linear or Coriolis acceleration combined with ionizing radiation. The quantitative evaluation of the functional state of the vestibular analyzer made it possible to obtain material on semicircular canal activity disturbances at different periods of radiation sickness and responses of the irradiated body, given various doses of gamma radiation, to angular and Coriolis acceleration. Experiments were performed on 250 rabbits and 22 dogs. Rabbits were exposed to the total gamma radiation at doses of 50, 100, 500, 800, 5000, 10000 rad; dogs experienced single and fractional radiation exposures at doses of 200 rad (γ-rays) and at doses of 500 and 350 rad (protons of 510 MeV). Specific conditions under which the astronaut's vestibular analyzer is functioning during space missions and our own experimental results make it possible to state that the vestibular analyzer serves as the critical organ in evaluation of radiation hazards during space flights. (auth)

848 RBE VALUES FOR FAST NEUTRONS IN CONNECTION WITH ESTIMATES OF THE RADIATION BURDEN IN SPACE. Graul, E. H.; Krueger, H.; Ruether, W.; Piroth, D. (Univ., Marburg, Ger.). pp 186-94 of Life Sciences and Space Research VII. Vishniac, W.; Favorite, F. G. (eds.). Amsterdam, North-Holland Publishing Co., 1969.

From 11th Plenary Meeting, Tokyo, Japan. See CONF-680530–(Vol.7); From Symposium on Biological Effects of Radiation in Space, Tokyo, Japan. See CONF-680555.

Much data concerning radiation in space as a serious danger to astronauts can be obtained in laboratories on Earth. For different parameters we investigated the relative biological efficiency (RBE) of 14-MeV neutrons on mice, rats and guinea pigs (wholly exposed). Also the mitosis inhibition for isolated cells was determined. The RBE values found were: for lethality in the $LD_{50/30}$-region—about 2 (for mice, rats and guinea pigs); for reduction due to radiation of living weight of different animals—2 to 3; for reduction of small gut weight of rats and guinea pigs—2.5 and 2; for histological changes in blood and albumin serum (rats and guinea pigs)—about 2; for the highly sensible cells of the lense epithelium from eyes of rabbits—2.5; for the mitosis inhibition of HeLa cells—2.5. The apparatus for radiation tests is described and measuring methods are indicated. The radiation of the whole body of mice, rats, and guinea pigs was determined by activating of $MgCl_2$ solution filled into phantoms. By means of a computer, the depth-dose curve can be determined for larger biological objects. (auth)

849 PREDICTION OF INTERINDIVIDUAL DIFFERENCES IN RADIOSENSITIVITY IN MAMMALS. Ueno, Y. (Kyoto Univ.). pp 201-6 of Life Sciences and Space Research VII. Vishniac, W.; Favorite, F. G. (eds.). Amsterdam, North-Holland Publishing Co., 1969.

From 11th Plenary Meeting, Tokyo, Japan. See CONF-680530–(Vol.7); From Symposium on Biological Effects of Radiation in Space, Tokyo, Japan. See CONF-680555.

Prediction of individual radiosensitivity of mammals is of interest to radiobiology on the one hand and it is also important to the clinical use of radiation. It has been reported that there is a relation between radiosensitivity in individual animals and homeostatic activity that allows prediction of individual radiosensitivity. In the present report, a phenomenon of metabolism was used to measure the homeostatic activity of an individual mouse DBA strain, 90 days old; that is, the metabolic rate was calculated from daily diet or water consumption, and body weight. Each mouse fasted completely for one day and the ratio between metabolic rates just before and just after the fast (value after fast/value before fast) was calculated to use as the index of homeostatic activity of each mouse. One week after fasting, the mice were exposed to x rays of 500 R and the ratio of metabolic rates just before and just after exposure was calculated again. Ten days after exposure the mice were sacrificed and the spleens were fixed in Bouin's solution. After fixing, the splenic weight was measured and an endogenous spleen colony count (more than 1 mm diameter)

was made, which was one response to radiation damage to the hematopoietic system. The results are summarized in tabular form. (auth)

850 EFFECTS OF PRENATAL X-IRRADIATION OF THE RAT ON POSTNATAL GROWTH AND MORTALITY. Sikov, Melvin R.; Resta, Corrine F.; Lofstrom, James E. (Wayne State Univ., Detroit). Radiat. Res., 40: 133-48(Oct. 1969).

Rats were irradiated after 10 days of gestation with 20 R (10^{20} group) or 100 R (10^{100} group), or after 15 days of gestation with 50 R (15^{50} group) or 185 R (15^{185} group). The incidence of stillbirth was increased only in the 15^{185} group while neonatal mortality was elevated in this and the 10^{100} groups. Birth weight was reduced in all groups other than the 10^{20} but growth was depressed only in the rats irradiated after 15 days of gestation. The relative growth of a number of organs, particularly the brain and spleen, was further reduced in these animals. The mortality of the rats of the 15^{185} group was most markedly altered although lesser changes were seen in the 10^{100} and 15^{50} groups; the effect on the females was greater than on the males. (auth)

851 STIMULATION OF THYMIC AND BONE MARROW REGENERATION IN IRRADIATED MICE BY PROTEIN FRACTIONS OF HUMAN SERUM AND SHEEP SPLEEN. Burger, M.; Knyszynski, Ahuva; Berenblum, I. (Weizmann Inst. of Science, Rehovoth, Israel). Radiat. Res., 40: 193-202(Oct. 1969).

Evidence is presented that the 19S alpha-2 globulin fraction, isolated from human serum or from sheep spleen, is capable of strongly enhancing regeneration of the mouse thymus damaged by radiation injury. This activity is preceded by enhancement of regeneration of the damaged bone marrow. The conditions for maximum activity of this protein fraction were studied in C57BL/6 mice submitted to four weekly irradiations of 170 R. Enhanced regeneration was obtained when each of the four injections of 19S alpha-2 globulin was given several hours before or after each irradiation, with a sharp optimum time of 2 hours before each irradiation. Increasing the number of injections beyond four did not achieve any demonstrable further increase in effect. (auth)

852 RADIOBIOLOGY OF EXPERIMENTAL TUMORS (SECOND PART). Muranyi-Kovacs, I. Rev. Pathol. Comp. Med. Exp., 69: 7-26(Jan.-Feb. 1969). (In French).

Effects of ionizing radiations on animal tumors, studied in vivo and in vitro, are reviewed, with a total of 319 references for parts I and II of this review. The emphasis in this part of the review is on the action of intermediate biological substances released from irradiated cells and acting on other cells at a distance. The existence of such substances seems to have been proven. At the molecular level, it was shown that peroxides are formed that may have injurious effects. It was also shown that these and other cytotoxic substances are transported via the blood and act on distant cells. Ionizing radiation also produces toxic substances from irradiation of nutrient substances in culture media that were shown to inhibit growth of HeLa cells and fibroblasts. Clinical studies also indicate distant effects of therapeutic irradiation on tumor cells. Host defense factors may act in support of necrohormones and radiotoxins in eliminating tumor cells, immunologic factors being important in this respect. In fact, irradiation of a tumor may release antigenic substances that then stimulate the host immunologic response, causing immune injury or elimination of unirradiated tumor cells. The role of the general adaptation syndrome in this regard is discussed. Research in the field of indirect or abscopal radiation effects is impeded by the low intensity and complexity of the reactions involved, with consequent difficulty in demonstrating them unequivocally. (BBB)

853 EXTRAPOLATION TO MAN OF THE DOSES REQUIRED FOR RADIOTHERAPY. Tubiana, M.; Frindel, E.; Malaise, E. (Institut Gustave Roussy, Villejuif, France). pp 713-20 of Progress in Radiology. Vol. I. Turano, L.; Ratti, A.; Biagini, C. (eds.). New York, Excerpta Medica Foundation, 1967. (In French).

From 11th International Congress of Radiology, Rome. See CONF-650907-(Vol.1).

Some factors that are important to quantitative extrapolation of irradiation dose to radiotherapy procedures such as the duration of intracellular recovery, kinetic growth of cell populations, and the modifications of growth produced by multiple irradiations were studied. Growth curves of reticulosarcomas in mice were compared after treatment with a dose of 600 R of x irradiation, and the cellular survivals were compared with those in unirradiated tumors. Effects of 0 deprivation on irradiation effects were estimated. Differences in cellular radiosensitivities were observed in vivo and in vitro. Biochemical synthetic activity of the adrenal medulla was studied in mice by measurement of tritiated thymidine incorporation after x irradiation. Incorporation was about five times greater in animals irradiated with a dose of 250 R than in animals irradiated with 100 R, when the labeled thymidine was injected 1 hr before sacrifice. Radiosensitivity of the spleen was measured at various times by observing cell survival and mitotic activity after an initial dose of 250 R of x irradiation. The numbers of splenic nodules decreased exponentially with irradiation dose. The curves obtained indicated a minimum dose sensitivity of 124 R for the medullary cells. At 3 hr after irradiation it was 145 R, and at 18 and 36 hr it was 92 and 65 R, respectively. Possible effects of multiple doses of x irradiation are discussed briefly. (BBB)

854 BIOLOGICAL EFFECTS OF IONIZING RADIATIONS. Hagen, U. (Kernforschungszentrum, Karlsruhe, Ger.). Arbeitsmed. - Sozialmed. - Arbeitshyg., 4: 7-11(Jan. 1969). (In German).

Several important biological reactions of microorganisms and animals to ionizing radiations were described and reviewed briefly. These included transfer of ionizing radiation energy to biological tissues, tissue ionization, radical formation, and alterations produced in cell constituents by irradiation. Inhibition of cell reproduction, and cell death caused by irradiation exposure, relative radiosensitivities of cells during various stages of reproduction, effects of irradiation on chromosomes, and treatment of radiation sickness were discussed in general terms. Relations between irradiation dose levels, initial symptoms of irradiation exposure at various doses, characteristic symptoms, and prognoses for recovery from irradiation exposure were tabulated. Irradiation injury to animal embryos, delayed somatic injuries produced by irradiation, effects of chronic, low-level irradiation, metabolic behavior of radioisotopes incorporated into animals, and maximum permissible radiation burden were discussed briefly. (BBB)

855 RADIATION INDUCED FETOPATHIES. Lefebvre, J. Union Med. Can., 97: 299-301(Mar. 1968). (In French).

Ionizing radiations can be teratogenic both in the animal and the human. Experimental use of radiations in the animal is reviewed with special mention of doses employed, time of insult, and effect produced on the foetus. As to the case of the human foetus, experience from therapeutic, diagnostic and accidental (use of atomic weapons) is discussed. (auth) (Canada)

856 X RADIATION AWARENESS IN MICE. Morris, D. D.; Feinstein, R. N. (Argonne National Lab., Ill.). Nature (London), 222: 688-9(May 17, 1969).

It is stated that animals are aware of x radiation, but the reason for this is unknown. Some studies are described with the acatalasaemic mouse (Genetics, 53: 923(1966)) to test a mechanism which has received consideration. The blood catalase activity of this mutant is about 1% of normal. The studies arose from the following possibilities: that a humoral factor may operate to provide the radiation awareness; that H_2O_2, as a product of the radiolysis of aqueous solutions, may serve as a cue in the well-known post-irradiation aversion to saccharin in mice. The acatalasaemic mouse provides the possibility of directly testing for H_2O_2. The mice studied received 200 R of x-radiation at 38 R/min, and post-irradiation saccharin aversion was determined. It was found that normal mice avoided saccharin to a significantly greater degree than did acatalasaemic mice. Since the only known difference between the two strains is in blood and tissue catalase, H_2O_2 must be involved in the aversion, the aversive stimulus being dependent on the presence of both H_2O_2 and catalase, and the production of a peroxidatic product of catalase. (UK) (auth)

857 PRELEUKEMIC APLASIAS. Bernard, Jean (Hopital Saint-Louis, Paris). Nouv. Rev. Franc. Hematol., 9: 41-8(Jan.-Feb. 1969). (In French).

The analytic study of preleukemic aplasias permit three types to be distinguished namely: pancytopenias, bicytopenias, and isolated aplastic cytopenias or dyserythropoiesis. The preleukemic aplasias are initiated by a particular agent as radiation or benzene; sometimes they are caused by genetic illness; at times they are primitive in appearance. Their chronology permits them to be classified under three headings: definite aplasia far in advance of leukemia, aplasic symptomatology inaugurating the leukemia, and pauci-blastic leukemia. The comparisons established between the initial stages of animal leukemia and the initial stages of human leukemia and the type of reversible clonal proliferation lead to the proposal of diverse interpretations on the nature of preleukemic aplasias. (tr-auth)

858 RADIOBIOLOGY OF EXPERIMENTAL TUMORS (FIRST PART). Muranyi-Kovacs, I. Rev. Pathol. Comp. Med. Exp., 68: 305-35(Nov.-Dec. 1968). (In French).

An extensive review is presented of radiation experiments employing animal tumors, with 319 references. Radiosensitivity of tumor cells in vivo as well as in tissue cultures and effects of radiation on cells under both conditions are described. In addition to

the direct effects of ionizing radiations, indirect effects are described. Cinematographic studies are presented. Some attempts are made to explain the varying radioresponses of different types of tumors. Many older studies are reviewed along with later findings. Numerous tables are presented with comprehensive compilations of results spanning the entire period of radiobiologic research in animal oncology. (BBB)

859 PHOTOCOAGULATION: RED, WHITE, BLUE, AND GREEN. Flocks, Milton (Stanford Univ., Palo Alto, Calif.). Trans. Pac. Coast Oto-Ophthalmol. Soc., 52: 213-29(1968).

The effects of visible laser light of various colors (wavelengths) on the retina of the monkey are compared. Experiments with a ruby, argon, and neodymium laser and xenon arc lamp are reported. The nature of the light source determined the character of the lesion produced. The principal variables were the duration, wavelength, and intensity of the flash of light. The continuous wave (CW) argon laser light can be used in durations intermediate between pulsed ruby laser and xenon arc. Experiments with neodymium (an invisible light whose double harmonic is green), and with Q-switched ruby lasers indicated that these light sources are not as effective in producing retinal lesions as either the long pulsed ruby or the xenon arc. The differences in the appearance of the lesions produced by the pulsed ruby laser and the xenon arc are described. The pulsed ruby laser used in moderate dose, after initiating a burn in the pigment epithelium, produces a structured lesion which appears to leave unaffected the inner layers of the retina. The longer acting xenon arc, after changing its light energy into heat at the pigment epithelium, produces a white puff-like lesion which affects all the layers of the retina and later scars down the entire thickness of the retina. The appearance of the lesions produced with the argon (blue-green cw) laser funduscopically look uniformly white like those produced by the xenon arc but can be made much smaller in size. Histologic studies suggest that the lesions produced with the argon laser affect the superficial layers of the retina more than does the ruby laser. The lesions produced affect the depth of the retina intermediately between that of the xenon arc and the ruby laser. The pulsed ruby laser, when used at high intensity, may produce small hemorrhages. The xenon arc may produce changes in the vitreous. The small pulsed ruby lesions may affect only the deep layers of the retina, in contrast to the heavier xenon arc lesions, that are more likely to affect all layers of the retina. The laser lesions, therefore, are less likely to affect the nerve fiber layer of the retina. (BBB)

860 IRRADIATION IN VITRO OF THE REGION OF HENSEN'S NODE IN THE MOUSE GASTRULA. Benoit, Jean (Institut d'Embryologie et de Teratologie Experimentales, Valde-Marne, France). Compt. Rend., Ser. D, 269: 724-7(Aug. 11, 1969). (In French).

Destruction, in vitro, by x rays of the region of Hensen's Node in the embryonic pole of the mouse gastrula resulted in the absence of the chord and deficiencies of development of the cephalic and somatic mesoderm. Correlatively, neurulation was diminished at the level of the head, still present in the anterior part of the trunk, but in general non-existent in the posterior region of the embryo. (tr-auth)

861 STUDIES OF THE ACTION OF LEUCOGENENOL ON THE MYELOID AND LYMPHOID TISSUES OF THE SUBLETHALLY IRRADIATED MOUSE. Rice, F. A. H.; Lepick, Joan; Darden, J. H. (American Univ., Washington, D. C.). Radiat. Res., 36: 144-57(1968).

Studies of the action of leucogenenol on the peripheral leukocytes, the myeloid cells found in bone marrow, and the lymphoid cells found in the spleen of sublethally x-irradiated mice strongly suggest that leucogenenol stimulates the maturation and/or cellular division of cells of both the myeloid and lymphoid series. Accordingly, as indicated by the increase in the number of peripheral leukocytes, as well as the increase in the number of myeloid and lymphoid cells found in the bone marrow and spleen, mice treated with leucogenenol appear to recover more rapidly than untreated controls. (auth)

862 REACTIVE PROCESSES IN THE CORTICAL MATTER OF RAT ADRENALS DURING THE INTERNAL EXPOSURE OF THE ORGANISM WITH ^{144}Ce. Truupyl'd, A. Yu.; Tokin, I. B. Dokl. Akad. Nauk SSSR, 185: 1166-8(Apr. 11, 1969). (In Russian).

In view of the importance of adrenal cortex for protecting the organism against effects of radiation, the reactive changes in the cortical tissue of male white rats were investigated after incorporation of ^{144}Ce. The animals were killed at periods ranging from 1 to 180 days after administration of the radioisotope and the mitotic coefficient, mitoses per 10,000 cells, was determined in the adrenal sections. It was found that within one day after incorporation of the isotope, the volume of the adreno-cortical matter increased while the sudanophobic layer disappeared; the mitotic activity was only slightly affected. During the first two weeks a progressive transformation took place and the mitotic activity was greatly reduced. During the later periods regeneration was noted and the mitotic activity did not exhibit any statistically meaningful deviation from the standard. In spite of the preferential accumulation of ^{144}Ce in the skeleton and the liver, its concentration was found to be high in the adrenal tissue during the first week but 4 to 5 weeks later, it was found only in the bony tissues. Thus the cortex conserves its regenerative ability, involving mitosis and endomitosis under formation of polyploid cells. (TTT)

863 BONE REMODELING DYNAMICS AFTER INTRAPERITONEAL ADMINISTRATION OF RADIOACTIVE SODIUM PHOSPHATE (^{32}P). Bures, M. F.; Wuehrmann, A. H. (Univ. of Alabama, Birmingham). J. Dent. Res., 48: 909-12(Sept.-Oct. 1969).

A tetracycline bone labeling method was used for quantitative evaluation of bone remodeling changes in tibias and mandibles of rats after intraperitoneal administration of radioactive sodium phosphate (^{32}P). Periosteal bone formation decreased during the 60-day experimental period, whereas endosteal formation rates were not altered significantly. (auth)

864 INFLUENCE OF ^{226}Ra AND ^{239}Pu ON THE DENTAL ROOT CANAL OF THE DOG. Taylor, Glenn N.; Rehfeld, Carl E.; Christensen, William R.; Jee, W. S. S. (Univ. of Utah, Salt Lake City). Contract AT(11-1)-119. J. Dent. Res., 48: 924-7(Sept.-Oct. 1969).

Radium-226 and ^{239}Pu were injected into dogs and the rate of decrease in diameter of the pulp chambers of the lower first molar of the left side of the mandible was studied by periodic radiograms. No significant change in the rate of decrease occurred as the result of irradiation. (auth)

865 BONE REMODELING DYNAMICS FOLLOWING LOCAL X IRRADIATION. II. Bures, M. F.; Wuehrmann, A. H. (Univ. of Alabama, Birmingham). J. Dent. Res., 48: 904-8(Sept.-Oct. 1969).

A tetracycline labeling method was used for demonstration of bone remodeling changes in mandibles of rats after unilateral local x irradiationof the mandible and tibia. A 5-mm diameter x-ray beam was used. Direct effects of 4,500 and 9,000 R exposures of two different radiation qualities were evaluated quantitatively. An assessment of abscopal effect was also made. (auth)

866 EFFECT OF IRRADIATION ON THE ERYTHROPOIESIS OF RATS AFTER STARVATION AND BLEEDING. Dragic, Marko; Ninkov, Vukosava; Ivanovic, Zora; Hajdukovic, Srdjan; Karanovic, Jovo (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Strahlentherapie, 138: 224-8(Aug. 1969).

The effect of radiation and direct postirradiation bleeding on the erythropoiesis of previously starved rats was investigated. Results showed that after a dose of 600 R the regenerative processes in the erythropoiesis of starved rats proceed in the same way as in normal controls. After postirradiation bleeding these processes started earlier compared with nonbled irradiated animals. No difference was observed in the dynamics and intensity of the regenerative processes of erythropoiesis between starved and normally fed animals. (auth)

867 RADIOSENSITIVITY OF AGRICULTURAL ANIMALS. Buldakov, L. A. (Inst. of Biophysics, Moscow). Radiobiologiya, 8: 671-5(1968). (In Russian).

In experiments on 24 lambs and ewes, changes in the composition of the peripheral blood after peroral administration of solutions of ^{90}Sr, ^{137}Cs, ^{144}Ce, and a mixture of these emitters were investigated. Fifteen animals of the corresponding age were used as controls. The dependence of the change in the hematological indices upon the amount of the isotope administered and the radiation doses in the tissues was established. The radiation doses in the skeletons of lambs, $\leq$1.5 rad/day, arising after peroral administration of 0.0035 μCi/g of ^{90}Sr, did not produce any changes in the composition of the peripheral blood. Among adult animals, a substantial decrease in the amount of lymphocytes occurs at dose rates in the skeleton of >0.5 rad/day. Such doses arise after peroral administration of 0.01 μCi/g of ^{90}Sr, 0.6 μCi/g of ^{144}Ce, or 0.8 μCi/g of ^{137}Cs. The degree of decrease in the number of erythrocytes is correlated with the increase in the radiation dose in the intestines. (JPRS)

868 ADDITIONAL HISTOLOGIC INVESTIGATIONS IN EXPERIMENTAL GRID RADIATION. Unger, Emil (Frederic Joliot Curie Staatliche Forschungsinstitut fuer Strahlenbiologie und Strahlenhygiene, Budapest). Strahlentherapie, 138: 346-54(Sept. 1969). (In German).

New facts are reported as observed after irradiation through a single slot or through grids on the testes of the rabbit, on the bone

marrow of the rat, and on the tumor of Guérin. Part of the observations are morphological demonstrations of the dose relationship. The other observations are mainly as follows: The damaged zone seems smaller than the grid opening after such type of irradiation; the intact zone is mostly broader than the damaged zone; in part of the organ irradiated through a grid, the damage seems less important than after irradiation through an open field. This is a morphological proof of the fact that the non-irradiated tissue has a protective effect on the surrounding damaged tissues. (auth)

869 CHANGE IN THE RADIORESISTANCE OF RATS UNDER CONDITIONS OF HYPOTHERMIA WITH VARIOUS METHODS OF ITS PRODUCTION. Gordeicheva, N. V.; Strokova, T. P. (Inst. of Medicobiological Problems, Moscow). Radiobiologiya, 8: 747-9 (1968). (In Russian).

The state of hypothermia, created by the method of hibernation or under conditions of hypoxia, increased the resistance of rats to γ irradiation at a dose of 800 R and had no effect in the case of irradiation at a dose of 1500 R. The most pronounced antiradiation action was exerted by a state of hypothermia produced under conditions of hypoxia. (JPRS)

870 CHANGE IN THE SYNAPTIC LAG OF THE NEUROMUSCULAR SYNAPSES OF RATS IN VARIOUS PERIODS OF ACUTE RADIATION SICKNESS. Cherkasov, V. F.; Nesterenko, V. S.; Kudryavtsev, V. D. (Inst. of Medical Radiology, Obninsk, USSR). Radiobiologiya, 8: 700-3(1968). (In Russian).

After a single whole-body irradiation at a dose of 900 R, a lowering of the thresholds of excitation of the synapses with a simultaneous decrease in the time of synaptic lag for a single stimulus were detected, which is apparently evidence of an increase in the reactivity of the cholinergic structures of the subsynaptic membrane of nerves. A substantial increase in the time of synaptic lag in the irradiated animals after stimulation at a frequency of 200 cps apparently occurs as a result of a disruption of acetylcholine synthesis. (JPRS)

871 THE REPRODUCTIVE CAPACITY OF RHESUS MONKEYS FOLLOWING X-IRRADIATION OF THE OVARIES. Baker, Terry G; Kelly, W. Alan; Marston, John H. (Medical School, Birmingham, Eng.). Strahlentherapie, 138: 355-60 (Sept. 1969).

The ovaries of 26 sexually mature rhesus monkeys were exposed to localized doses of 500 to 7000 R x irradiation. The reproductive capacity of the animals following treatment was studied. Normal menstrual cycles were maintained after exposure to 500 to 4000 R. They ceased immediately after 7000 R, and after a period of irregular cycles following 5000 R x rays. Eggs, both fertilized and unfertilized, were recovered at laparotomy 6 to 30 months following doses of less than 7000 R, and most of the ovaries were normal in appearance. The incidence of small atrophic ovaries increased with the higher radiation-doses used. Two of the animals that were not laparotomized maintained their pregnancies. One resulted in the birth of a normal female infant, while the other foetus is still in utero at the fifth month of gestation. (auth)

872 RADIATION AND WOUND HEALING. A STUDY OF THE GAIN OF COLLAGEN CONTENT IN THE DAMAGED SKIN OF IRRADIATED RATS. Stajic, Jovan; Jovanovic, Milan (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Strahlentherapie, 138: 361-4(Sept. 1969).

The process of collagenesis in excized skin wound of rat exposed to 700 R of whole-body γ irradiation was studied. Results showed that the gain of collagen in the wounds of irradiated animals starts 2 to 3 days later than in nonirradiated controls. Thereafter, the collagen levels continually increased in both experimental groups but in the group of irradiated wounded animals the collagen concentration permanently showed a lower level than in the nonirradiated controls. Possible explanations for this phenomenon were discussed. (auth)

873 REGENERATION OF COLON MUCOSA IN RATS FOLLOWING LOCAL AND WHOLE-BODY RADIATION. Arenz, Frederike; Oehlert, Wolfgang (Univ., Freiburg i. B.). Strahlentherapie, 138: 365-74(Sept. 1969). (In German).

After a local irradiation of the rectum in rats with doses of 800 to 2000 R, acute lesions of the mucosa were observed, followed by regeneration which seems to start from the resting crypts. This regeneration is practically complete within two months. During this phase of regeneration the differentiation toward goblet-cells is decreased; this zone includes progressively all crypts. Unlike the mucosa of the small intestine, the rectal mucosa loses the differentiation ability, even three months after whole-body irradiation with twice 800 R. This is shown by a reduced number of cells, an increase in cell proliferation and a more rapid turnover of the mucosa. (auth)

874 ELECTROCARDIOGRAPHIC STUDY OF CARDIAC DAMAGE FOLLOWING IRRADIATION OF CANINE HEARTS. Takaoka, A. (Kyoto Prefectural Univ.). Radiol. Clin. Biol., 38: 182-96(1969).

Radiation-induced cardiac damage after a single exposure was studied by examining the ECG and S-GOT level in dogs. Autopsy was performed and was followed by coronarography and histologic studies. Early and late effects on the ECG were observed in the form of prolongation of the Q-Tc interval which indicates myocardial damage. The early effect, i.e., the first prolongation of the Q-Tc interval varied in proportion to the cardiac dose. The first prolongation disappeared within a few weeks after irradiation. Organic lethal myocardial damage was observed when the Q-Tc interval was again prolonged. The S-GOT rose to more than 220 units 3 to 6 weeks before the second prolongation of the Q-Tc interval. At autopsy, a typical finding was fibrous change in the myocardium which was sharply limited to the irradiated area. The time of onset of the late effect varied with the radiation dose to the heart. Statistical analysis suggests that this correlation might be a negative straight line on a log-log diagram when the radiation is given in a single dose. These experimental results suggest that, in patients receiving radiotherapy for intrathoracic or breast cancer, the prognosis is influenced by radiation-induced myocardial damage. (auth)

875 EFFECTS OF SMALL RADIATION DOSES AND LOW DOSE RATES ON THE DEVELOPMENT OF MAMMALS. Langendorff, Hanns (Univ., Freiburg i. B.). Strahlentherapie, 138: 181-5(Aug. 1969). (In German).

New tests are described, examining the teratogenic effects in different laboratory animals, of one irradiation with doses up to 100 R. The problem of the influence of low doses on the embryonal development in mice is discussed. (auth)

876 ANIMAL EXPERIMENTAL STUDIES ON THE DETERMINATION OF RADIATION-INDUCED INJURY TO THE KIDNEY THROUGH RADIOISOTOPE RENOGRAPHY USING ^{131}I IODOHIPPURIC ACID. Bargon, G.; Emrich, D. (Univ., Goettingen, Ger.). Fortschr. Geb. Roentgenstr. Nuklearmed., 109: 40-50(July 1968). (In German).

The kidneys in 30 rabbits were transplanted to a subcutaneous position and one kidney in each animal γ-irradiated with 4000 R. Function was continuously monitored with an isotope nephrogram using ^{131}I hippuran; the effectiveness of this method was evaluated. It was found that after 7 days, following irradiation there was a significant increase in the biological half-life of the ^{131}I hippuran. Forty-two days after irradiation there was a reduction in the impulse rate during the vascular phase (first phase) and in the maximal impulse rate of the secretory phase (second phase). Simultaneously, there was a significant increase in maximal impulse rate during the vascular and secretory phases in the non-irradiated kidney; this was regarded as functional increase in the normal organ. By using a method that can compare the function of the two sides, it was possible to determine changes in impulse rate as early as 7 days after irradiation. The abnormalities in the nephrogram were compared with morphological findings in the irradiated kidneys and good correlation was found with respect to the timing and direction of the changes. It is suggested that an isotope nephrogram be obtained before and after any course of radiation treatment that might involve a kidney, in order to recognize renal damage as early as possible. (auth)

877 THE INVESTIGATIONS ON THE POSSIBILITY OF VITAL DIAGNOSIS OF POST-RADIATION AUTOINFECTION IN SLAUGHTER ANIMALS. Kossakowski, S. Med. Wet. (Poland), 24: 449-53(1968). (In Polish).

The bacteriological investigation of blood of rabbits irradiated with 1000 and 1200 R doses of x rays, carried on during the whole course of acute radiation sickness gave strictly negative result. During the bacteriological investigation of internal organs and muscles of dead rabbits the increase of microorganisms isolated from all internal organs was noted. The inoculations from heart, muscles, and infrapatellar lymph nodes were positive only in 50%. Among the anatomo-pathological changes, hemorrhage, extravasation of blood in subcutaneous tissue and internal organs, and ulceration of bowels were especially evident. Those results show that vital bacteriological investigation of blood cannot be regarded as the indicator of post-radiation autoinfection, and the investigation of muscles and internal organs points out that there are hypothetical possibilities of using meat of animals slaughtered in the autoinfection period for dating-which requires further investigation. (auth) (NSA of Poland)

878 EXPERIMENTAL APPROACHES TO STUDYING THE EFFECTIVENESS OF PARTIAL-BODY PROTECTION. Abramova, G. M.; Ginsburg, E. V.; Kuzin, R. A.; Nevskaya, G. F.; Popov, V. I.;

Sychkov, M. A.; Shafirkin, A. V.; Yurgov, V. V. Kosm. Biol. Med., 3: No. 4, 54-9(July-Aug. 1969). (In Russian).

An experimental procedure was developed to conduct radiobiological studies of the effectiveness of partial-body protection from high-energy proton beams. In all the experiments, carried out on dogs, a shield was placed on body portions equal in their weight. The restrained animals were exposed to irradiation for 10 to 15 min. The dose gradient did not exceed ± 10%. The partial-body protection provided a 10-fold decrease of the dose effect in the shielded portion of the animal body. (auth)

879 SIGNIFICANCE OF IMMUNOBIOLOGICAL INDICES IN DETECTION OF RADIATION DAMAGE. Lvitsyna, G. M.; Davydova, S. A. Kosm. Biol. Med., 3: No. 4, 37-40(July-Aug. 1969). (In Russian).

The immunobiological reactivity of dogs was studied during single exposures to 126 MeV protons at doses of 55, 89, and 160 rads. Reflecting delicate changes in the total reactivity of the living body, immunological tests indicated its high sensitivity even to nonlethal radiation doses. Correlation between changes of natural immunity factors and value of the absorbed energy and degree of shifts of other biological indices was established. Short-term decrease of bactericidal properties of skin and absolute phagocytic index was found upon proton irradiation even with a dose of 55 rads. As the dose increased, earlier and more significant changes of immunobiological indices were detected. (auth)

880 ON THE BIOLOGICAL EFFECT OF 50 MeV PROTONS ON CELLS OF THE INTESTINAL EPITHELIUM OF MICE. Mastryukova, V. M.; Strzhizhovskii, A. D. Kosm. Biol. Med., 3: No. 4, 41-5(July-Aug. 1969). (In Russian).

The results of studying the mitotic activity, content of chromosome aberrations, and amount of cells in sections of crypts and villi of the intestinal epithelium of mice exposed to a total irradiation with 50 MeV protons at doses of 250, 500, and 750 rads are presented. The above indices showed substantial shifts, restoring, however, during a 9-day observation period. (auth)

881 ON HEMOPOIETIC CHANGES IN DOGS DURING FRACTIONAL PROLONGED IRRADIATION. Sbitneva, M. E.; Trushina, M. N.; Gvozdeva, N. I.; Samoilova, E. M. Kosm. Biol. Med., 3: No. 4, 33-6(July-Aug. 1969). (In Russian).

Experiments on dogs were carried out to study the hemopoietic effects of fractional prolonged γ irradiation (repeated four times at a dose of 50 R/day once a week). The exposure caused a short-term decrease of the leukocyte and thrombocyte content and a reduction of the neutrophil phagocytic activity in the peripheral blood, and a decrease of the amount of myelokaryocytes in bone marrow punctates. Tests with sodium nucleate showed that activity of leukopoiesis remained sufficiently high. (auth)

882 DIFFUSE SPECTRAL REFLECTANCE MODIFICATION OF SKIN BY U.V. IRRADIATION. Anglin, J. H. Jr.; Raz, A. I. (Univ. of Oklahoma Medical Center, Oklahoma City). Photochem. Photobiol., 10: 273-81(Oct. 1969).

Irradiation of guinea pig skin in vivo with light shorter than 300 nm produced a significant decrease in 330 to 400 nm reflectance. A similar decrease in reflectance was seen by irradiation of excised guinea pig and human skin. Chemical or physical vasodilation had no effect on the 240 to 400 nm reflectance. Irradiation of guinea pig skin in vivo with light longer than 300 nm produced no change in 330 to 400 nm reflectance unless photosensitized with 8-methoxypsorban (8-MOP). UV irradiation of skin (in the presence of suitable endogenous or exogenous photosensitizers) may result in the formation of new products that effectively absorb 330 to 400 nm photons. (auth)

883 RENAL DAMAGE FOLLOWING ADMINISTRATION OF ^{203}Hg AS DEMONSTRATED BY ANIMAL EXPERIMENTS. Schmidt, K.-J.; Walther, G.; Brod, K. H.; Wolf, R. (Johannes-Gutenberg-Univ., Mainz). Fortschr. Geb. Roentgenstr. Nuklearmed., 111: 407-14(Sept. 1969). (In German).

Radiation dose to the kidney following the application of ^{203}Hg-neohydrin was calculated for animal experiments. Histological examination eight days after a dose of 14 rads showed distinct tubular damage. This is the result either of pure radiation damage or a combination of radiation and the mercury. The use of this substance in nuclear medicine is inadvisable. Disturbances in the permeability of the glomerular apparatus was interpreted as a result of radiation damage. (auth)

884 CATALASE ACTIVITY IN VARIOUS RAT TISSUES AFTER X-RAY IRRADIATION, LD_{50}. Capalna, S.; Stefan, M. (Inst. of Normal and Pathological Physiology, Bucharest). Rev. Roum. Physiol., 6: 75-80(1969).

Catalase activity was followed in various organs of 100-g male rats x irradiated with a single whole-body dose of 1000 R. Catalase activity was determined in homogenates of the organs up to 48 hr postirradiation. In nonirradiated rats the most intense activity was observed in the liver, where H_2O_2 decomposition released on an average 2900 μatoms O_2 per mg protein per 15 min at 37°C; then followed kidney with an average activity of 2550. The spleen homogenate also showed significant catalase activity (1298), but only half that of liver and kidney. Catalase activity in heart homogenate was much lower (423). The lowest catalase activity (53) was noted in the total brain homogenate. Catalase activity in liver homogenate showed the most marked decrease after irradiation with an LD_{50} dose. At 30 min after irradiation the inhibition was 14%; after 1 hr it was 21%, after 2 hr 33%, and after 24 hr 54%. Then, 48 hr after irradiation the recovery of catalase activity began. Catalase activity in kidney homogenate also underwent a decrease following irradiation. After 24 hr 50% inhibition of the initial activity was seen and after 48 hr a recovery much more intense than in the liver. Though spleen is an extremely radiosensitive organ, the changes of catalase activity in that tissue were less marked than in liver and kidney. The lowest value (84%) occurred 2 hr after irradiation, then gradual recovery occurred; after 48 hr it reached almost the normal value. Catalase activity in the heart homogenate 30 min after irradiation decreased by 12% but then began the process of recovery, so that after 1 hr the decrease was only 8% and after 2, 24, and 48 hr catalase activity was normal. (BBB)

885 CORNEAL INJURY PRODUCED BY CARBON DIOXIDE LASER RADIATION. Leibowitz, Howard M.; Peacock, George R. (Army Medical Research Lab., Fort Knox, Ky.). Arch. Ophthalmol. (Chicago), 81: 713-21(May 1969).

The corneal injury that follows exposure of the rabbit eye to CO_2 laser radiation is described and the extent of clinical change is correlated with the level of radiation incident upon the cornea. The radiation source used operates in the ir at a wavelength of 10.6 μ. Radiation dose was expressed in terms of the function $P\sqrt{t}$ (where P = power output, t = exposure time). After exposure at $P\sqrt{t}$ 3.8 to 5.5, no corneal lesion was seen in any animals. With $P\sqrt{t}$ of 5.7 to 6.7, the irradiated area of the cornea in 7 of 14 animals had a relatively uniform, sharply demarcated, light gray appearance. The superficial epithelium, initially gray and roughened, appear ragged and moth-eaten several hours later. Healing was complete 24 hr after laser exposure. After $P\sqrt{t}$ 7.1 to 11.9 exposures, the epithelium in the irradiated area of the cornea was roughened and grayish-white in appearance and stained lightly with fluorescein. There was a correlation between the radiation dose and the coloration of the resulting corneal injury. The lower radiation doses produced a gray lesion, the higher doses, a denser and increasingly whiter lesion. Epithelial denudation progressed and involved the entire circular area of the laser burn within 24 hr. Healing was complete 96 hr after laser exposure. Little inflammation accompanied the corneal injury. With all power outputs and exposure times used, clinically detectable ocular damage was limited to the cornea. Two other levels of corneal injury were defined, and the dose of CO_2 laser radiation capable of producing each level of injury is given. (BBB)

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Refer also to abstracts 573, 580, 589, 616, 624, 629, 688, 689, 749, 800, 804–806, and 855.

886 DISTURBANCES IN THE DEVELOPMENT AND ERUPTION OF TEETH IN CHILDREN AS THE RESULT OF THE IONIZING RADIATION. Barer, G. M. Stomatologiya, 47: 5-9 (May-June 1968). (In Russian).

Long-term (6 to 15 yr) clinico-roentgenological observations were made on 10 patients that received teleradiotherapy or its combination with application gammatreatment for facial skin hemangioma at an early age. Marked changes were noted in the soft tissues, teeth, and jaws in the irradiation zone. The severity of these alterations depended on the radiation dose absorbed and the age of the patients at the time at which irradiation was performed. Particularly pronounced lesions in the dentomaxillary system were caused by radium therapy in early childhood. (auth)

887 PROBLEMS OF INDIVIDUAL DOSE HEIGHT IN FRACTIONATED RADIATION. Kaercher, K. H. (Univ., Heidelberg). Fortschr. Geb. Roentgenstr. Nuklearmed., 110: 388-91(Mar. 1969). (In German).

Limitations of single dose height in fractionated radiation treatment of malignant tumors are discussed. It is stressed that the possibility of tissue damage of normal organs must be kept in mind in order to achieve successful results. (tr-auth)

888 EFFECT OF RADON INHALATION AT SWIERADOW SPA ON THE WATER AND ELECTROLYTE BALANCE IN ARTERIAL HYPERTENSION. Lukasik, S.; Szczeklik, E.; Halawa, B.;

Rog-Malinowski, M.; Lukasikowa, W. (Scientific-Therapeutic Center, Swieradow, Poland). Pol. Med. J., 8: 21-8(1969).

Translated from Pol. Arch. Med. Wewn., 40: No. 3, 21-8(1968).

The effect of Rn inhalation on parameters that might affect blood pressure was studied in 19 hypertensive and 15 normotensive patients. The effect of one inhalation of Rn was evaluated on the basis of urinary excretion of sodium, potassium, and creatinine; diuresis; sodium and potassium levels in the blood; and arterial blood pressure and pulse. The patients were further observed after a series of Rn inhalations lasting 24 days. Radon inhalation did not affect water-electrolyte metabolism; in particular, no increase of diuresis or natriuresis was observed. On the other hand, a significant decrease of diuresis was observed in all patients, with an associated decrease of natriuresis in the hypertensive patients after Rn inhalations. This decrease occurred on the fourth day, and could be explained by the disappearance of the effect of the changed environmental conditions, that have a positive diuretic effect during the first days. In the hypertensive patients smaller diuresis was observed, as compared with the control group, that could be due to disturbances of mechanisms regulating the water-electrolyte metabolism in hypertensive patients. The results failed to confirm those of Z. Wiktor et al., who claimed that Rn inhalations have an influence on diuresis and natriuresis. (BBB)

889 ROUTINE USE OF RADIOGOLD FOLLOWING OPERATION FOR OVARIAN CANCER. Moore, David W.; Langley, Ivan I. (Emanuel Hospital, Portland, Ore.). Trans. Pac. Coast Obstet. Gynecol. Soc., 34: 42-8(1966).

Complications arising in 74 patients with ovarian carcinoma treated with a combination of surgery and intraperitoneal instillation of radiogold are reported. The amount of ^{198}Au used varied from 100 to 200 mCi, with 150 to 175 mCi most frequently used. No complications considered serious were encountered in any of the patients. Thirty % complained of transient nausea within 48 hr of treatment, 20% had transitory elevation of temperature, and 5% had diarrhea which subsided with simple medication. In the first 20 consecutive cases, the patients' excreta were saved and scanned for possible contamination with radioisotope, fearing that the bowel wall might be penetrated during administration. This procedure was abandoned when no contamination was found. Two patients developed a small indurated tract at the site of injection within a year, which is thought to represent leakage of the isotope into the tract of injection, probably due to faulty technique. One patient had a mechanical bowel obstruction 10 months after ^{198}Au administration. The abdomen and pelvis were free of adhesions but the peritoneum had a thickened, semiopaque smoky appearance which has been reported by other authors following the use of intraperitoneal radiogold. Some patients developed extensive adhesions, making further exploration arduous if not impossible following the use of radiogold. Advantages of ^{198}Au over ^{32}P are cited. (BBB)

890 NEOPLASTIC RETICULOSIS ASSOCIATED WITH CHRONIC MYELOGENOUS LEUKEMIA. Fukuda, Takao (Tohoku Univ., Sendai). Virchows Arch., A, 345: 310-23(1968).

Reticulum cell proliferation as an undesirable side-effect of irradiation or drug therapy was studied in 12 cases of neoplastic reticulosis associated with chronic myelogenous leukemia. These leukemic patients received long-term treatment with cytostatic drugs and irradiation. Blastomatous reticulum cells appeared in the peripheral blood terminally. Neoplastic reticulosis was prevalent in post-mortem findings. Most cases had been treated with 6-mercaptopurine (6-MP), Myleran, or Tespamin and some patients had received x-ray or ^{60}Co irradiation. The alkylating agents Myleran and 6-MP are known to produce a marked chromosomal damage and cellular abnormalities, particularly giant cells. The type of reticulosis observed was characterized by: marked proliferation of pleomorphic reticulum cells with formation of giant cells, a terminal dissemination of atypical reticulum cells via the blood stream, and histological patterns specific for the lymph nodes, spleen, and bone marrow. The lymph nodes showed a sinus reticulosis, blastomatous in nature. Lesions in the spleen were granulomatous, and the bone marrow had nodular lesions and tumors suggestive of reticulum cell sarcoma. The relation between leukemia and reticulosis was discussed and it was concluded that the treatment of leukemia with cytostatics and/or irradiation may induce a secondary neoplastic reaction. (BBB)

891 TREATMENT OF THYROTOXIC PATIENTS WITH ATRIAL FIBRILLATION. McLarty, D. G.; Harden, R. McG.; Alexander, W. D. (Western Infirmary, Glasgow). Scot. Med. J., 14: 17-22(Jan. 1969).

Selection of ^{131}I dose in the treatment of thyrotoxic cardiac anomalies is considered, and the incidence of hypothyroidism, as a serious consequence of radioiodine treatment, is reported. Of the 96 patients, 39 were given antithyroid drugs commencing 4 days following the therapeutic ^{131}I dose. The dose was 4 to 6 mCi for patients with impalpable glands, 6 to 7 mCi for those with minimal but definite diffuse enlargements, and 7 to 25 mCi for those with larger glands. The estimated dose was increased by 25% in patients with nodular glands and in patients with cardiac failure. Forty-five (47%) of the 96 patients required more than one dose and 10 (10%) received four doses before finally being rendered euthyroid. Fifty-two (54%) required more than 10 mCi ^{131}I and 28 (30%) more than 20 mCi. Six (6%) required 50 mCi ^{131}I or more. Of these, one had a single dose of 50 mCi, one had an ablation dose of 80 mCi following initial therapy with 15 mCi, three had four doses (total 66, 62, 75 mCi), and one had eight doses totaling 152 mCi. There was no relation between the dose of ^{131}I required and the patient's age or duration of symptoms. The average dose of ^{131}I administration was 18 mCi. Factors that may have influenced doses of radioiodine required are discussed. Hypothyroidism developed in 43% of patients within the period of follow-up; 39% of those receiving less than 10 mCi ^{131}I and 60% receiving 10 to 20 mCi became hypothyroid. In 50 of 96 patients, atrial fibrilation spontaneously reverted to sinus rhythm following treatment with radioiodine. Reversion to sinus rhythm did not occur, however, until the patient was euthyroid. The high incidence of hypothyroidism indicates that radioiodine is not ideal treatment in patients with atrial fibrilation and thyrotoxicosis. It is suggested that such patients be treated with antithyroid drugs in the first instance for control of the thyrotoxicosis. (BBB)

892 ON THE INCIDENCE OF LATE HYPOTHYROIDISM AFTER TREATMENT OF HYPERTHYROIDISM WITH RADIO-IODINE-131. (RESULTS OF A SURVEY OF 96 PATIENTS WITH A FOLLOW-UP OF 5 TO 12 YEARS). Berger, M.; Peyrin, J. O.; Briere, J. (Faculte de Medecine, Lyon). Lyon Med., 218: 1489-507(Dec. 10, 1967). (In French).

As a late complication of the radiotherapy of thyrotoxicosis the incidence of hypothyroidism was evaluated on the basis of the dose and schedule of ^{131}I administration and other factors. The dose of ^{131}I given was calculated in mCi according to the following criteria: palpated volume of the thyroid gland, 48-hr radioiodine uptake value, and the slope of the fixation curve between the 48th and 60th hr. The doses used varied from 7 to 13 mCi for small goiters to 15 to 22 mCi for large goiters accompanied by cardiac symptoms. A thyroid dose of 10,000 Rad was aimed at. Follow-up studies of 96 patients 5 to 12 yr postirradiation revealed 30.2% with hypothyroidism and 11.4% approaching this state. These figures are similar to those in other studies. Possible mechanisms of ^{131}I-induced delayed hypothyroidism discussed include one relating to vascular radioinjury and progressive anoxia of follicular cells, one postulating progressive autoimmune destruction of the cells, and the most likely one of radioinjured cells that continue to divide through a limited number of mitoses. Recommendations are made for administration of repeated smaller doses of ^{131}I to treat thyrotoxicosis, and annual tests of protein-bound ^{127}I to detect hypothyroidism, that often goes undiagnosed and untreated. (BBB)

893 LATE IRRADIATION INJURIES MASQUERADING AS RECTAL CARCINOMA. Bueschen, Anton J.; Sawyers, John L. (Vanderbilt Univ., Nashville). S. Med. J., 61: 1236-8(Nov. 1968).

Patients may develop rectal lesions suggestive of carcinoma many years after irradiation treatment for carcinoma of the cervix. Four such patients with rectal lesions are described that had received irradiation for cervical carcinoma from 14 to 29 years previous to the development of the rectal lesion. The first case, a 66-yr-old woman complaining of rectal bleeding and back pain was treated for a carcinoma of the cervix 17 yr earlier with 7200 mg-hr of intrauterine and contracervical vaginal Ra. Because of persistent rectal drainage and bleeding, an abdominoperineal resection was done. Case 2, a 63-yr-old woman was treated for carcinoma of the cervix at age 34, with Ra implantation (4400 mg-hr). A 2-by-2 cm firm mass was palpable on the anterior rectal wall, and on sigmoidoscopy it appeared to be carcinoma. Biopsy on three occasions showed only necrotic tissue with acute and chronic inflammation and no evidence of carcinoma. Case 3, a 60-yr-old woman had had a hysterectomy and an unknown amount of Ra treatment. This patient presented with a rectal lesion 24 yr later. The surgeons who examined the rectal lesion required eight biopsies to rule out carcinoma. Case 4, a 62-yr-old woman had external and internal irradiation for squamous cell carcinoma of the cervix at age 42. She developed a late irradiation reaction in the rectum. The lesion was so similar to carcinoma that biopsies were taken on several occasions before the diagnosis was accepted that no malignancy was present. These benign late irradiation lesions should be treated by conservative measures which consist of a bland diet, mild laxatives, enemas, and hydrocortisone locally in a water-soluble base. If this form of therapy is unsuccessful in eliminating the patient's complaints

of persistent rectal discharge, bleeding, and tenesmus, then a diverting colostomy may be necessary. (BBB)

894 UNUSUAL RADIATION HAZARD FROM ELECTRON MICROSCOPE. Bush, D.; Browne, R. M. (Univ. of Birmingham, Eng.). Health Phys., 16: 798(June 1969).

A radiation survey of an electron microscope of Japanese manufacture was made, which lead to the location of a high count rate associated with numerals and letters engraved with non-luminous paint on a panel around two condenser control knobs. The radiation proved to be low energy beta, from ^{147}Pm, giving a dose rate of about 45 mR/hr to the fingertips of the operator. It was surprising to find a radiation hazard associated with a non-luminous paint. (UK)

895 THYROID CANCER IN OLMSTED COUNTY 1935–1965. Verby, John E.; Woolner, Lewis B.; Nobrega, Fred T.; Kurland, Leonard T.; McConahey, William M. (Mayo Clinic, Rochester, Minn.). J. Nat. Cancer Inst., 43: 813-20(Oct. 1969).

To evaluate the trend of thyroid cancer from 1935 to 65, inclusive, reports of all diagnosed cases occurring in bona fide residents of Olmsted County, Minnesota, were identified and reviewed. There were 46 acceptable cases of thyroid cancer (group 1). The average annual incidence rates (age-adjusted to the 1950 U. S. white population) increased from 1.7 to 3.1 to 3.6/100,000 population in 1935 to 44, 1945 to 54, and 1955 to 65. The increase, most marked between the first and second decades, is not statistically significant. There has probably been an upward trend, but it is believed to reflect an increasing awareness of the problem and improved diagnostic capabilities for thyroid cancer in the community. The age range was 11 to 91 yr and the median age was 50 yr. The female-to-male ratio was 3:1. In addition, 21 patients (18 females and 3 males) had occult, grade 1, papillary carcinoma of less than 1.5 cm in diameter without evidence of regional metastasis (group 2). These lesions are considered innocuous and relatively benign in the absence of clinical evidence of metastasis to cervical nodes. In 16 of the 21 cases, the diagnosis was made between 1955 and 1965. If these occult lesions were included, the age-adjusted incidence rates/100,000 population increased significantly from 2.2 to 3.7 to 6.1, respectively, in the three periods. The increased recognition of these occult lesions, particularly since 1955, is believed to account for this upward trend. If the increased exposure to diagnostic irradiation, radioactive fallout, and other environmental radiation has significantly affected the incidence of the thyroid cancer in adults, our survey procedure is not sufficiently sensitive to detect the effect. If the Olmsted County data were extrapolated to the population of the United States, based on the group-1 cases during 1955 to 65, we would expect about 7,000 persons in the country to develop clinically identifiable thyroid cancer each year. (auth)

896 MUCOUS GLAND TUMORS OF PARANASAL SINUSES. Rafla, S. (Manitoba Cancer Treatment and Research Foundation, Winnipeg, Can.). Cancer, 24: 683-91(Oct. 1969).

Thirty-seven cases of paranasal mucous gland tumors are presented. The natural history of these tumors is discussed, with emphasis on the relative frequency of nerve involvement (13 of 41) that is particularly common in ethmoidal and sphenoidal tumors. Most of the patients who died with disease had active local tumors (14 of 15 cases). Results of treatment are shown—the 5- and 10-yr survival rates free of disease were 21% (6 of 28) and 0% (none of 12) respectively. Factors that may affect the results of treatment of these tumors are discussed; the site of origin is important, with the best results reported in tumors of the nasal fossa. A combined approach by surgery and radiotherapy yields the the best results with a 5-year survival rate of 33% (5 of 15). Apart from pleomorphic adenoma, there is no significant difference between the results of treatment of various histologic types. Paranasal mucous gland tumors are moderately radiosensitive with 8 of 22 tumors disappearing completely under treatment and another 4 showing very good regression. Cylindromas and adenocarcinomas appear to be the most radiosensitive tumors. The technique and dosage of radiotherapy are illustrated. (auth)

897 X-RAY THERAPY IN A CASE OF ACUTE GRANULOCYTIC LEUKEMIA. Anday, George J.; Tishkoff, Garson (Veterans Administration Center, Los Angeles. Univ. of Southern California, Los Angeles. Univ. of California, Los Angeles). Cancer, 24: 826-31(Oct. 1969).

A 44-year-old woman with cervical lymph node enlargement was thought at first to be suffering from malignant lymphoma. The cervical lymph nodes were x-irradiated, with resulting decrease in size. Months later, the initially normal blood picture changed, a bone marrow aspirate showed dense myeloblastic infiltration, and the diagnosis of acute granulocytic leukemia was established. This was the time when our study was performed on bone marrow aspirate and peripheral blood. Cytogenetic analysis of the bone marrow aspirate revealed mostly diploid chromosome constitution with fuzzy outlines of the chromosomes, but without structural changes. The blood cultures, however, showed wide spectrum of structural alterations. The discrepancy is explained by the two different sources of study yielding two different cell types—myeloblasts in the bone marrow, but mostly radiation-effected lymphocytes in the blood cultures. (auth)

898 BREAST NEOPLASMS IN WOMEN TREATED WITH X RAYS FOR ACUTE POSTPARTUM MASTITIS. A PILOT STUDY. Mettler, Fred A. Jr.; Hempelmann, Louis H.; Dutton, Arthur M.; Pifer, James W.; Toyooka, Edward T.; Ames, Wendell R. (Univ. of Rochester, N. Y.). J. Nat. Cancer Inst., 43: 803-11(Oct. 1969).

The incidence of benign and malignant breast tumors in 606 women treated with x rays for acute postpartum mastitis was determined by mail survey. The total cumulative x-ray doses per breast ranged from 75 R (air) to more than 1000 R. The follow-up period in most cases was from 10 to 25 yr. Thirteen confirmed cases of breast cancer were observed instead of the 5.86 cases expected in a comparable group of women in the general population of upstate New York. In 5 of the 13 women with cancer, only one breast was treated; in each case, the cancer arose in the irradiated breast. Twenty-five surgically removed benign breast tumors were reported rather than the four to five cases expected. The incidence of benign tumors appeared to have increased in the untreated as well as in the treated breasts. There was no good evidence of a correlation between the dose and the incidence of malignant and benign tumors. Although a strong association is established between excess breast neoplasms and prior x-ray treatments for mastitis, lack of adequate control studies means that the radiation exposure per se cannot be implicated with certainty as an etiologic factor in the neoplastic transformation. Because irradiation is known to induce breast neoplasms in several species of animals and because of reports of excess breast neoplasms in women after exposure to ionizing radiation, it seems likely that the x-ray treatments were factors in the development of the excess breast tumors. We conclude therefore that at least some breast cancers in this series of women could have been induced by the prior x-ray exposures. (auth)

899 COSMIC RADIATION AND SPACE EXPLORATION. 2. PROBLEMS OF RADIATION BIOLOGY. Delahaye, R.-P. Rev. Corps Santee Armees, 8: 529-44(Aug. 1967). (In French).

A bibliographic study is made of the radiobiological problems connected with space exploration. Biological studies made with primary and galactic cosmic radiation and the radiation belts are reviewed. The biological effect of protons and its possible effect on space flight are discussed. The risks of a space flight below and through the radiation belts are considered. (J.S.R.)

900 OCCUPATIONALLY RELATED RADIATION INJURIES IN NORTH RHEIN-WESTPHALIA DURING 1965–1967. Rahm, G. (Dienststelle des Staatliches Gewerbearztes, Dusseldorf). Arbeitsmed. - Sozialmed. - Arbeitshyg., 4: 12-14(Jan. 1969). (In German).

The incidences of irradiation injuries on North Rhein–Westphalia and West Germany for previous years are reported. From 1955 to 1962, 366 irradiation injuries were reported in West Germany. Of these, 76 were occupationally incurred. From 1953 to 1967, 135 irradiation injuries were reported in North Rhein–Westphalia. Only a few cases of whole-body irradiation incidents occurred at nuclear installations, and in the entire world there were 34 fatalities at such sites during the last 20 yr. Up to 1965 there were no reported cases in Germany of acute whole-body irradiation that exceeded 100 rem. From 1965 to 1967, 31 out of 45 cases of irradiation injury reported in North Rhein–Westphalia involved acute injuries of the skin of the hands. Acute skin injuries followed exposure to estimated doses of up to 12,000 R of x ray or short exposures to 960 mCi of ^{60}Co, deuteron-irradiated sources of 1 Ci, etc. There were 13 cases of acute skin injuries reported where the irradiation dose was from 1000 to 6000 R. In 18 other cases skin injuries were reported from chronic irradiation exposure to ^{226}Ra or x rays, where the lower limit of doses received were from 3000 to 5000 R. Blood changes were observed in 9 cases of irradiation. Leucocyte or thrombocyte counts decreased after small dose of irradiation, larger chronic irradiation doses damaged the bone marrow and erythropoiesis, while with very high irradiation doses received from up to 2500 mCi of ^{226}Ra incorporated in the patient bone marrow functional failure and, infrequently leukemia developed. (BBB)

901 MATERNAL IRRADIATION: ITS REPERCUSSION ON THE FETUS. Usandizaga-Pombo, J. M. (Hospital Civil de Bilbao, Spain). Acta Obstet. Ginecol Hisp. Lusit., 16: 357-88(Sept.-Oct. 1968). (In Spanish).

A bibliographic review is given of data available on the effects

of maternal irradiation on the fetus. The topics discussed are the effect of radiation on feminine germinal cells, effect of radiation on the embryo, effect of radiation on the subsequent life of the fetus, radiation burden of women, and methods of protection. (J.S.R.)

902 EFFECTS OF HIGH ENERGY X IRRADIATION ON THE OVARIES OF WOMEN IN REPRODUCTIVE AGE. Tagawa, Tetsuo (Osaka City Univ.). Osaka City Med. J., 13: 103-22 (Mar. 1968).

High doses of 15 MeV betatron x irradiation delivered to the ovaries of women in reproductive age and the effects on the basal body temperature, some hormone secretions, and the histological structure of the ovaries were observed. The change in 3-β-hydroxysteroid dehydrogenase activity was also studied. In most cases, there seemed to be no immediate effect upon the basal body temperature measurements following high-dosage irradiation of the ovaries, when given from just before ovulation to the time of menstruation. The excretion of urinary total estrogen was at a lower level than the pre-irradiation level. This occurred within 30 days after the beginning of irradiation, with some fluctuations. The level of 17-KS was not significantly changed at the 40th day. However, there was a declining tendency of the estrogen/17-KS ratio after irradiation. The level of pregnandiol was decreased following irradiation. There was a tendency of 3-β-hydroxysteroid dehydrogenase activity to decrease in the corpus luteum following exposure to 2000 rad. No activity was observed with 1000 rad. A marked decrease of the ovarian weight following irradiation with 4000 rad was found, and also a negligible number of primordial follicles were noted. However, no prominent destruction, such as grossly visible necrosis or hemorrhage, of the ovarian tissue was found. (NSA of Japan)

903 CLINICO-LABORATORY AND CYTOGENETIC OBSERVATIONS OF PERSONS SUBJECTED TO PROFESSIONAL IRRADIATION WITH GAMMA-NEUTRON SOURCES. Donev, Ivan; Zhivkov, S.; Kirov, K.; Vascov, L.; Boulanov, I. (Inst. of Physics, Sofia). Strahlentherapie, 138: 197-204(Aug. 1969).

Health Physical surveys of workers exposed to ionizing radiation showed an increase of blood pressure in exercise tests. Also increased were capillary fragility, serum beta-lipoproteins, and several transaminases. In addition, doses of less than one rad per year induced chromosome changes in leukocytes. (H.B.G.)

904 NUCLEAR RESIDUE IN PERIPHERAL ERYTHROCYTES IN PERSONS EXPOSED TO LONG-TERM RADIATION. Kriklava, J.; Vich, Z.; Koskova, D. Vnitr. Lek., 15: 223-8(Mar. 1969). (In Czech).

A study was undertaken on the effect of chronic exposure to small doses of ionizing radiation on the frequency incidence of residual nuclear fragments in the peripheral erythrocytes of employees with professional radiation exposure. Feulgen's cytochemical method was used, 100,000 cells evaluated, and the result interpreted as positive if at least one nuclear fragment was reliably found. In our series of 173 controls and 717 exposed persons we were able to show a correlation between the increased incidence of positive findings and duration of exposure in years. No correlation with the age of the examinees could be established. (auth)

905 MEDICAL STUDY PERFORMED DURING MANNED FLIGHTS OF SOYUZ-3, SOYUZ-4, SOYUZ-5 SPACECRAFTS. Vorob'ev, E. I.; Nefedov, Yu. G.; Kakurin, L. I.; Egorov, B. B.; Egorov, A. D.; Zerenin, A. G.; Kozyrevskaya, G. I. Kosm. Biol. Med., 3: No. 4, 46-54(July-Aug. 1969). (In Russian).

The preliminary results of medical observations performed during manned Soyuz-3, 4, and 5 space flights are summarized. Changes in physiological reactions of cosmonauts when within space cabins were similar to those found in previous flights. Medical data recorded during the egress of cosmonauts from the spacecraft are given. Analysis of the accumulated material suggests that spacecrew members had no pathological changes throughout the entire mission. Physiological changes observed were regarded as adequate responses to the effects of space flight factors. (auth)

906 THE PERIOD AND NATURE OF HAZARD IN CLINICAL RENAL TRANSPLANTATION. III. THE HAZARD TO TRANSPLANT KIDNEY SURVIVAL. Moore, Thomas C.; Hume, David M. (Medical Coll. of Virginia, Richmond). Ann. Surg., 170: 25-9 (July 1969).

Factors influencing kidney survival in 119 renal transplant patients receiving immunosuppressant drugs and/or local irradiation or whole-body irradiation are presented. Three patients are living with transplanted kidneys that have been functioning more than 5 yr. Two received related living donor (RLD) first kidney transplants and one a cadaver donor (CD) second kidney transplant. Three additional patients are surviving on functioning second, third, and fourth CD kidney transplants more than 5 yr. Twenty-seven other patients have had functioning kidney transplant survival for 3- to 5-yr. One patient, still living, received whole-body radiation prior to the first RLD transplant and lost this kidney at 52 months from slowly progressive failure in transplant function. The patient with long transplant survival that had received whole-body irradiation had also received isonicotinic acid hydrazide for tuberculosis. This drug is known to produce a relative pyridoxine deficiency and is closely related chemically to a compound, semicarbazide, found to have an immunosuppressive effect. These two unusual circumstances of irradiation and drug administration, in addition to the routine immunosuppression, may have been factors in the prolonged survival of the kidney. (BBB)

907 CASE RECORDS OF THE MASSACHUSETTS GENERAL HOSPITAL: ABDOMINAL IRRADIATION FOLLOWED BY DIARRHEA AND TWENTY-FIVE YEARS LATER BY MALABSORPTION, DIABETES, HEADACHES, AND DIPLOPIA. Strole, William E. Jr.; Castleman, Benjamin (Massachusetts General Hospital, Boston). New Engl. J. Med., 281: 314-23(Aug. 7, 1969).

The case history of a 60-yr-old man is presented who had received a large dose of radiation to the abdomen in his youth that was soon followed by diarrhea and chronic abdominal distress. Diabetes and a malabsorption syndrome also developed 25 yr later and he died as a result of a central-nervous-system process. Whether the whole illness was interrelated, radioinduced, and of pancreatic origin are discussed. Microscopic examination of the pancreas at autopsy showed marked fibrosis, more in the tail and body than in the head. The bulk of the damage, with replacement by fibrosis, was to the acinar tissue rather than the islets. There were some vascular changes, but may not be attributed unequivocally to the radiation since a similar picture may be seen in patients with nonspecific chronic pancreatitis who have not received radiation. However, it was suspected that the irradiation had a role. No previously reported cases of pancreatitis or of pancreatic dysfunction after heavy irradiation were discovered in the literature except that of a second case that is described. A 57-yr-old man underwent resection of a teratocarcinoma of the left testis at the age of 34 yr and received 3000 to 4000 R to the pelvis, para-aortic region, and left kidney, with an area just above and to the left of the umbilicus probably receiving a total dose of 6000 to 7000 R. After the irradiation, watery diarrhea occurred for 2 yr. At 10 yr postirradiation, weight loss and peripheral edema appeared insidiously, and malabsorption syndrome with hypoalbuminemia was found that was treated with pancreatic extract, that gradually lost its effectiveness. Eleven yr postirradiation a fibrotic stricture of the transverse colon developed, and 4 yr later the small bowel perforated. Additional support for the concept of radiation damage to the pancreas was provided by the development of diabetes mellitus and profound malabsorption. (BBB)

908 RADIODERMATITIS. Lever, W. F. Presse Med., 77: 1024-5(June 7, 1969). (In French).

The histopathology of radiodermatitis is described briefly. The acute form develops within days of a massive dose of radiation, erythema leading to desquamation and pigmentation, and to ulceration if the dose is sufficiently high. The chronic form may be manifested months or even years after irradiation. It consists of cutaneous atrophy, irregular hyperpigmentation, telangiectasia, ulceration, and hyperkeratosis. In the acute form the epidermis shows intra- and extracellular edema and pyknotic nuclei. The hair follicles, sebaceous glands, and sweat glands all show degenerative signs. An inflammatory infiltrate extends throughout the dermis and may even invade the epidermis. The walls of some blood vessels may be edematous, their endothelia proliferated and lumens thrombosed. In the severe form the epidermis undergoes necrosis. In the chronic form the epidermis may show hyperacanthosis or hyperkeratosis. The cells resemble those of senile keratosis. The collagen fibers of the dermis are swollen and show variable staining. Some are pale and other intensely eosinophilic. The number of elastic fibers may be increased. Dermal vessels show thickened, fibrotic walls with reduced lumens or may even be occluded. Thrombosis and recanalization may be present. Hair follicles and sebaceous glands may disappear. In ulcerated lesions, even large underlying vessels may be obliterated. Spinocellular carcinoma may appear as a late carcinogenic effect of irradiation. (BBB)

909 EFFECTS OF MEDIASTINAL IRRADIATION UPON RESPIRATORY FUNCTION FOLLOWING MASTECTOMY FOR CARCINOMA OF BREAST: A FIVE-YEAR FOLLOW-UP STUDY. Cudkowicz, L.; Cunningham, M.; Haldane, E. V. (Victoria General Hospital, Halifax, Can.). Thorax, 24: 359-67(May 1969).

Radiation injury of the lungs was examined on the basis of a 5-yr follow-up study of respiratory function in 36 patients receiving mediastinal irradiation following mastectomy for carcinoma of the breast. Physiological dead space diminished progressively, reaching a maximum decline at 12 months following irradiation. Partial recovery occurred thereafter with a leveling out at about 62% of the preradiation level. Pulmonary diffusing capacity also declined rapidly but recovery began after 18 months and improved to within normal limits by the fifth year of the follow-up. The residual volume immediately increased at the end of radiotherapy but rapidly and permanently returned to normal. Some increase in alveolar ventilation was apparent throughout and continued for at least 4 yr, presumably as a result of the permanently reduced dead space. (BBB)

910 QUANTITATIVE MEASUREMENTS OF DNA CONTENT OF CERVICAL CANCER CELLS BEFORE AND AFTER TEST DOSE RADIATION. Sugimori, Hajime; Busberg, S. B. (Mt. Sinai Hospital, New York). Amer. J. Obstet. Gynecol., 104: 829-38(July 15, 1969).

The DNA content of cervix cancer cells before and after a test dose of irradiation was measured by microspectrophotometry in 36 patients. The dose of radiation administered was either 3000 R (6 × 500 R) or 1600 R (2 × 800 R) by transvaginal cone with 250-kV x rays or 1600 Rad by external irradiation (^{60}Co or betatron). In seven patients an application of Ra was made instead. Biopsies were taken seven days after completion of the test dose. Before irradiation the DNA values of each tumor showed a considerable variation, ranging from hypodiploid to octoploid. However, the modal DNA value was present in all cases. This modal DNA value was designated DNA stem-line. The DNA stem-line was found between the diploid and tetraploid value in 29 cases and showed two peaks at hyperdiploid and hypertriploid values. Generally, many cells with increased DNA value appeared after irradiation. According to the type of change in the DNA distribution pattern the cases were classified into three groups. This classification agreed with radiosensitivity study responses, indicating that the morphological changes have their basis in chemical alterations. Good agreement between morphological observations and pattern of DNA distribution was also observed in the two cases that showed peculiar patterns. The value of DNA stem-line, range of DNA distribution, and the type of change after irradiation did not correlate with clinical stage, age of patient, or degree of differentiation. The mean nuclear size and mean DNA value in tumor cells were compared as well as the ratios of these measurements before and after irradiation. Some correlation was observed, but no precise conclusions could be drawn. (BBB)

911 SKELETAL CHANGES FOLLOWING IRRADIATION OF CHILDHOOD TUMORS. Katzman, Harold; Waugh, Theodore; Berdon, Walter (Columbia-Presbyterian Medical Center, New York). J. Bone Joint Surg., 51A: 825-42(July 1969).

The findings of a long-term follow-up study of children that were treated for tumors by radiotherapy are reported. The prospecti included 51 patients with Wilm's tumor and 46 with neuroblastoma treated from 1940 to 1959. Three other children with a retinoblastoma, a hemangiolymphangioma of the lower extremity, and a cavernous hemangioma of the wrist, respectively, were included in this study because of their interesting postirradiation changes. Radiotherapy had been given as orthovoltage x rays with one exception, a 7-week-old infant with a retinoblastoma that was treated with 22.5 MeV x rays from a betatron. The average tumor dose was 2850 R, and the range was from 1400 to 4284 R. Treatment periods ranged from 15 to 180 days, the average period being 28 days. The skeletal sequelae observed were changes in the vertebral bodies, scoliosis, hypoplasia of the ileum and rib cage, osteocartilaginous exostoses, epiphyseal destruction with limb-length discrepancy and deformity, and postirradiation sarcoma. These complications of radiotherapy were related to the age of the patient, the nature of the primary disease, and the amount and quality of the radiation administered. When direct tumor invasion of bone existed, as with some neuroblastomas, the final changes following irradiation were magnified. It is believed that this is due to the combination of tumor destruction and radiation effect. Since irradiation injures the growth centers of bone and time is required for the changes in the skeleton to occur, long-term follow-up of these patients is important. A quarter of the patients required orthopedic treatment. (BBB)

Radiation Effects on Plants

Refer also to abstracts 563, 660, 664, 671, 673, 675, 677–683, 685–687, 690, 746, and 846.

912 EFFECTS OF RADIATION DURING SPACE FLIGHT ON MICROORGANISMS AND PLANTS ON THE BIOSATELLITE II AND GEMINI XI MISSIONS. de Serres, Frederick J. (Oak Ridge National Lab., Tenn.). pp 62-6 of Life Sciences and Space Research VII. Vishniac, W.; Favorite, F. G. (eds.). Amsterdam, North-Holland Publishing Co., 1969.

From 11th Plenary Meeting, Tokyo, Japan. See CONF-680530-(Vol.7); From Symposium on Biological Effects of Radiation in Space, Tokyo, Japan. See CONF-680555.

The results of recent experiments with the lysogenic bacteria, Escherichia coli and Salmonella typhimurium, the bread mold Neurospora crassa and the flowering plant Tradescantia on the Biosatellite II and Gemini XI Missions will be summarized. In the lysogenic bacteria experiment on the Biosatellite II mission significant effects of space flight were found on both growth rate and the induction of prophage. In that part of the Neurospora experiment on both the Biosatellite II and German XI Missions, utilizing non-dividing and inactive spores, no difference was found in the genetic effects of radiation between the flight and ground samples. In that portion of the Neurospora experiment on the Gemini XI mission utilizing rapidly-metabolizing spores the genetic effects of radiation were less serious in the flight samples than the ground samples. In the Tradescantia experiment on the Biosatellite II Mission, the irradiated flight material, in general, produced increased rates of cell death, abortion of pollen, loss of reproductive integrity, as well as other abnormalities in cell structure and function. In some of the experiments there were found significantly genetic effects of space flight alone, and the enhancement of various genetic effects of radiation under weightlessness was no more than 2- or 3-fold. (auth)

913 INACTIVATION OF RHIZOPUS STOLONIFER SPORANGIOSPORES BY SINGLE AND COMBINED TREATMENTS OF HEATING, CHILLING, AND GAMMA-IRRADIATION. Buckley, Patricia M.; Sommer, N. F.; Coon, D. A.; Dally, Merriel; Maxie, E. C. (Univ. of California, Davis). Contract AT(11-1)-34. Radiat. Res., 40: 26-36(Oct. 1969). (UCD-34-P-73-24).

Germinating sporangiospores of Rhizopus stolonifer (Ehrenb. ex Fr.) Lind. were more susceptible than nongerminating sporangiospores to inactivation (loss of colony forming ability) by single treatments of heating, chilling, or gamma-irradiation. Susceptibility to heat injury increased with increasing pretreatment incubation time up to 6 hours maximally allowed for germination. Sensitivity to radiation, in contrast, was greatest in spores incubated for 3 hours. The temperatures (39–46°C) and irradiation doses (50–200 krad) used in most treatments were below the maxima tolerated by fruits commonly attacked by this fungus after harvest. Although the nongerminating spores were markedly resistant to single applications of heat or radiation within those limits, a strong inactivation effect (<1% survival) was obtained when radiation + heat (125 krad + 46°C/5 minutes) were applied in sequence. The interaction was less pronounced with treatment in reverse sequence. With germinating spores (6-hour incubation), an even greater synergistic effect (<0.1% survival) resulted from heating (39°C 5 minutes) followed by irradiation (125 krad). Thus, maximum synergism was obtained in nongerminating spores with a radiation heat sequence and in germinating spores with a heat-radiation sequence. With both nongerminating and germinating spores, heat and radiation had a stronger interaction than heating and chilling. (auth)

914 COMPARISON OF THE DEVELOPMENTAL RESPONSE OF DIPLOID AND TETRAPLOID PHALARIS FOLLOWING IRRADIATION OF THE DRY SEED. II. DISTRIBUTION OF CHIASMATA BETWEEN AND WITHIN NUCLEI. Prasad, A. B.; Godward, M. B. E. (Queen Mary Coll., London). Radiat. Bot., 9: 159-66(1969).

The effects of filtered x-rays (M_1 and M_2) and unfiltered x-rays (M_1) on chiasma frequency and distribution between and within nuclei in Phalaris canariensis (2n = 12) and P. minor (2n = 28) were studied. Doses used were 10 and 30 kR filtered x-rays and 10 and 20 kR unfiltered x-rays. No significant correlations of the distribution of chiasmata between bivalents of the nuclei in either species were found. There was only a slight reduction of the number of chiasmata per cell as the result of irradiation. (auth)

915 FLOWER COLOUR CHIMERAS IN GLASSHOUSE CARNATIONS, DIANTHUS CARYOPHYLLUS L. Farestveit, B. (Royal Veterinary and Agricultural Coll., Copenhagen). Kgl. Vet.-Landbohoejsk., Arsskr., 19-33(1969).

Electron irradiation of 56 cultivated varieties of glasshouse carnation Dianthus caryophyllus L. was carried out in order to investigate the degree to which the varieties are chimeral for flower color. The following results were obtained: In 21 varieties the presence of flower color chimeras could not be demonstrated; a total of 29 varieties were found to be chimeral for 2 flower colors (dichimeras); and 6 varieties were found to be chimeral for 3 flower colors (trichimeras), a condition not previ-

ously described in carnations. The experiments show that the glasshouse carnation has a considerable ability to preserve stable chimeras. In addition, the occurrence of stable trichimeras must be considered to indicate that the apical meristem of the carnation is at least bitunicate, and that the tunica layers are stable and independent of each other and of the corpus. (auth)

916 ULTRAVIOLET RADIATION (2537 A) EFFECTS ON SPORE GERMINATION IN THE MOSS, FUNARIA HYGROMETRICA HEDW. Mueller, T. A.; Mueller, Mary K. (Adams State Coll., Alamosa, Colo.). Radiat. Bot., 9: 283-90(July 1969).

Spores from the moss Funaria hygrometrica were irradiated in distilled water with a germicidal lamp and plated on inorganic salts media plus 1.2% agar. Initial growth was under gold fluorescent lamps followed by culture under cool white fluorescent lamps. Microscopic observations of germination and early protonemal development, as well as gross protonemal growth on Petri dishes, were used to obtain survival curves for the respective characteristics. The survival curves had a shoulder showing multiplicity in the range 4–7. Doses of the order of magnitude of 24,000 erg/mm^2 were needed to obtain a kill of 90%. Spores irradiated with uv radiation immediately after being placed into distilled water showed no photoreactivation after 30 hr of growth. (auth) (UK)

917 EFFECT OF PROTRACTED ULTRASONIC IRRADIATION ON THE GROWTH OF SEEDLINGS OF VICIA FABA. Watmough, D. J.; Oliver, R.; Cavanagh, J. (Churchill Hospital, Oxford). Nature (London), 222: 773(May 24, 1969).

An irradiation effect in a small ultrasonic cleaning bath on the growth of the main tap root in broad bean seedlings is reported. Ultrasound at 70 kHz was employed, at 10 ms pulses. Daily growth rates of the roots are shown graphically. The continuously irradiated seedlings did not show an increase of root length, and on about the third day the growth rate started to decline. Some of the seedlings did not survive the irradiation period. It was established that the effect was not due to temperature changes, but must be attributed to damage to the meristem cells. The effect was similar to that observed under continuous γ-irradiation at 2.5 R/hr. (UK)

918 DNA CONTENT OF NUCLEI IN THE EMBRYONIC ROOT APICES OF DRY SEEDS OF ALLIUM CEPA AND THEIR RADIATION RESPONSE. Brunori, Alberto; Ancora, Giorgio (CNEN, Rome). Caryologia, 21: 261-9(1968).

DNA cytophotometry showed the simultaneous occurrence of nuclei with 2C and 4C DNA content in the radicle meristems of dry seeds of two varieties of Allium cepa; in some meristems all nuclei measured were 2C. When seeds were germinated in ^{3}H-thymidine, very few cells (0,18%) entered mitosis unlabeled, thus demonstrating that most of 4C nuclei in radicle meristems were not in the G_2 phase, but belonged to cells of the differentiated line. When seeds were irradiated in the dry state, the first post-irradiation mitoses to appear showed chromosome aberration. Only at the following collection times a certain amount of anaphases with chromatid aberration (B') (up to 50% in the first mitotic cycle) was seen. As the cell population responding to x rays with B' did not appear in the first germination period, it is presumed that the chromatid response does not represent the response of the late G_1 period. It seems, therefore, very probable that the chromatid damage is induced by an indirect effect of x rays. This secondary effect was overlapping with the chromosome response of the G_1 period. (auth)

919 EFFECTS OF GAMMA RAYS ON CERTAIN VARIETIES OF GRAPES. Koshel'nik, I. I.; Pil'gun, A. L. pp 213-19 of Mutagenez Sel'skokhozyaistvennykh Rastenii. Kovarskogo, A. E. (ed.). Kishinev, Izdatel'stvo Kartya Moldovenyaske, 1968. (In Russian).

The results of research on the effects of γ radiation on the morphological and biological parameters of certain varieties of grapes widespread in Moldavian Russia, are reported. (tr-auth)

920 DETERMINATION OF TRACE ELEMENTS IN RICE BY NEUTRON ACTIVATION ANALYSIS. Lee, Y. Y. (Seoul National Univ.); Travesi, A. J. Nucl. Sci. (Seoul), 9: 23-34 (1969).

Several varieties of blanched and unblanched rice were subjected to activation analysis following exposure to thermal neutrons. The number of trace elements identified was fourteen. In most cases, quantitative assays required quick chemical separation prior to gamma-counting. With very few exceptions the concentration of trace elements varies only moderately between the different varieties of rice. Blanched rice contains about one third to one half the amount of trace elements found in unblanched rice; that means, a high concentration of trace elements prevailed in the shells. (H.B.G.)

921 INCREASE IN THE SOIL GERMINATION OF SEEDS OF WOODY PLANTS UNDER THE INFLUENCE OF γ IRRADIATION. Kudinov, M. A. (Central Botanical Garden, Minsk). Radiobiologiya, 8: 763-4(1968). (In Russian).

Optimum doses of γ rays, for increasing germination of air-dried seeds of 20 species of woody plants are presented. For most of the species of honeysuckle, buckthorn, turf, ash, and hawthorn, the stimulating dose is between 0.5 and 10 kR; for Tsumi apple, broom, and barberry these increased to 60 kR. (JPRS) (TSS)

922 EFFECTS OF IONIZING RADIATION ON THE TYROSINE AND PHENYLALANINE METABOLISM IN PLANTS. Kuzin, A. M.; Fomenko, B. S.; Medvedev, A. I. (Inst. of Biological Physics, Pushchino on the Oka, USSR). Radiobiologiya, 8: 736-41(1968). (In Russian).

An increase in the content of phenylalanine, tyrosine, and total amino acids was detected by paper chromatography in seedlings of plants with various radiosensitivities, γ-irradiated at a dose of 20,000 R, in comparison with a nonirradiated control. The increase resulted from a more rapid decrease in their amount with age in the control plants. A disturbance of the metabolism of the investigated compounds in broad beans, peas, and kidney beans was observed during the entire experiment (120 hrs); in barley, cotton, sunflower, and cabbage the metabolic disturbance was transitory. (JPRS)

923 MODIFICATION OF THE RADIOMIMETIC EFFECTS OF NITROSOGUANIDINE BY CYSTEINE IN PLANTS. Kaul, B. L. (Max-Planck-Institut fuer Zuechtungsforschung, Cologne). Experientia, 25: 74-5(Jan. 15, 1969).

Resting seeds of barley and secondary roots of Vicia faba were treated with nitrosoguanidine exclusively or in combination with L-cysteine. In the latter case the radiomimetic effect was reduced by about 50%. It was assumed that this reduction was caused by a change in the oxygen level of the cells. (H.B.G.)

Radiation Effects on Microorganisms

Refer also to abstracts 598, 657, 663, 668–670, 672, 819, 854, 877, and 912.

924 DIFFERENTIAL RESPONSES OF SINGLE CELLS AND AGGREGATES OF MYCOPLASMAS TO ULTRAVIOLET IRRADIATION. Furness, Geoffrey (New Jersey Coll. of Medicine and Dentistry, Newark). Appl. Microbiol., 18: 360-4(Sept. 1969).

Except for Mycoplasma fermentans strain PG 18, single-cell suspensions of M. arthritidis, M. fermentans (ATCC 19989), M. hominis type 1, M. orale types 1 and 2, M. pneumoniae, and M. salivarium were inactivated exponentially by ultraviolet (uv) irradiation, in contrast to broth cultures containing clusters of elementary bodies. The susceptibility of the mycoplasmas was unaffected by storage at 2 to 4 C and at −70 C, by sonication, and by filtration. The rate of inactivation was dependent on the intensity of the radiations but independent of the concentration of the cells. Therefore, single-cell suspensions of these mycoplasmas could be differentiated from aggregates of cells by exponential inactivation of the colony forming units (CFU). By this criterion, the CFU of M. arthritidis in the exponential phase of growth consisted of single cells, in contrast to the other species in which the CFU contained two or more elementary bodies. Even though the cultures of M. fermentans (PG 18) were grown from single cells, they were not homogeneous in their susceptibility to uv light. Neither were cultures of M. arthritidis and M. orale type 1 grown from single cells that had survived irradiation. (auth)

925 THE EFFECTS OF HIGH INTENSITY VISIBLE AND ULTRAVIOLET LIGHT ON THE DEATH OF MICROORGANISMS. Chichester, C. O.; Maxwell, W. A. (Univ. of California, Davis). pp 11-18 of Life Sciences and Space Research VII. Vishniac, W.; Favorite, F. G. (eds.). Amsterdam, North-Holland Publishing Co., 1969.

From 11th Plenary Meeting, Tokyo, Japan. See CONF-680530–(Vol.7); From Symposium on Biological Effects of Radiation in Space, Tokyo, Japan. See CONF-680555.

The expectation that microorganisms would be exposed to very high visible light intensity in a space environment led to the investigation of the killing of microorganisms by visible light. The carotenoid-containing yeast Rhodotorula glutinis was one of the several organisms investigated. It was found that despite the carotenoid content of the organism it can be killed by endogenous photosensitized oxidation. While the effects of various parameters such as culture age, temperature, etc., were studied, particular emphasis was placed upon the development of action spectrum, determination of sites of action and the mechanism by which cells

are killed. The portion of the spectrum responsible for lethality lies between 300 and 400 nm with an apparent maximum response around 390 nm. The nucleus appeared to be damaged, as evidenced by a mutagenic effect when cells were radiated with light above 300 nm. Previously the only reported mutagenic responses from light of these wavelengths have been noted when cells have been irradiated in the presence of added sensitizing dyes. Increased leakage of irradiated cells indicated permeability membranes have undergone damage. Overall respiration of the cells is also decreased at a rate corresponding to the loss in viability. Such random damage to cells indicates that whatever the damaging species is, it must be quite non-specific. The sensitizing agent could be a free radical and evidence has been developed to support such a proposal. The sulfhydryl-containing compounds cysteine and gluthathione are capable of protecting the cells from death. Since these compounds are known to protect the organisms from ionizing radiation by the trapping of free radicals, it is logical to presume that the damaging species is a free radical. Little or no protection is offered to the microorganism by fat-soluble antioxidants such as tocopherol and related species. This would indicate that the primary lethal site must be in the water phase. It is likely that dehydration of the cells such as could be expected in a spacial environment would initially increase their suspectibility to irradiation, but upon intense dehydration could also result in their increased resistance. (auth)

926 ROLE OF O_2 AND N_2 IN THERMORESTORATION OF HYDRATED BACTERIAL SPORES. Suchanek, Gerda; Miura, Toshiyuki; Grecz, Nicholas (Illinois Inst. of Tech., Chicago). Radiat. Res., 40: 222-32(Oct. 1969).

Fully hydrated spores of the highly radioresistant organism, Clostridium botulinum 33A exposed to 0.8 Mrad ^{60}Co showed a characteristic pattern of survival associated with thermorestoration. When temperature during radiation was controlled at 0–100°C, the lowest viable cell count was at 0°C. Above 0°C radiosurvival gradually increased by 1 to 1½ log cycles, reaching a peak at 75–80°C. Above 80°C, a rapid drop in survival occurred presumably caused by heat itself. The general features of the above survival pattern were observed in water saturated with N_2 as well as in water saturated with O_2. Radiosurvival of spores in oxic water was at all temperatures approximately 1 log cycle lower than that in N_2-saturated water although the general features of the survival curves were approximately the same. An analysis of the shapes of survival curves in N_2 and O_2 suggested that the gradual radioprotection in the temperature range between 0°C and 80°C was due to annealment of lethal radicals in anoxic water, i.e., probably ·OH. The lethal radicals in oxic water (probably $\cdot HO_2$) appeared not to be annealed appreciably. (auth)

927 ISOLATION OF DEFECTIVE LYSOGENS FROM SIMIAN VIRUS 40-TRANSFORMED MOUSE KIDNEY CULTURES. Dubbs, D. R.; Kit, Saul (Baylor Univ. Coll. of Medicine, Houston, Tex.). J. Virol., 2: 1272-82(Nov. 1968).

Rescue of simian virus 40 (SV40) from hamster and murine cell lines transformed by nonirradiated or by ultraviolet (uv)-irradiated SV40 (10^{-3} to 10^{-6} survival) was studied. A combination of tests was employed to detect induction of SV40 synthesis: co-cultivation with susceptible monkey kidney (CV-1) cells; treating mixtures of transformed and CV-1 cells with uv-irradiated Sendai virus (uv-Sendai) prior to co-cultivation; and plating untreated or uv-Sendai treated mixtures of transformed and CV-1 cells with freshly trypsinized CV-1 cells. The first and second tests provided a measure of the total infectious SV40 yield per culture, and the third test provided a measure of the frequency of induction (fraction of transformed cells giving rise to infectious centers). With the combination of tests, SV40 was rescued in all trials from TSV-5 hamster cells, mKS-BU100 mouse cells, and from several lines of mouse kidney cells transformed by uv-irradiated SV40 (mKS-U lines). The frequency of induction was about 7×10^{-2} for TSV-5 cells, about 3×10^{-3} for mKS-BU100 cells, greater than 10^{-4} for the mKS-U lines that were good yielders, and about 10^{-5} to 10^{-4} for the mKS-U lines that were average yielders. SV40 of a plaque type different from parental virus was rescued from four of the mKS-U cell lines. Virus was also easily rescued from: tumor cells produced from the mKS-A line of transformed mouse kidney cells; mouse kidney cells transformed by SV40 that were rescued from mKS-BU100 cells; and tumor cells (HATS) that were produced by inoculating newborn hamsters with SV40 rescued from mKS-BU100 cells. The frequency of induction of HATS cells was of the same order of magnitude as the frequency of induction of TSV-5 cells. In a study of the kinetics of virus induction, it was shown that SV40 could be detected 28, 40, and 48.5 hr after uv-Sendai treatment of mixtures of CV-1 and TSV-5, HATS, or mKS-BU100 cells, respectively. Although all of the mKS-U lines contained the SV40-specific tumor antigen, some were poor virus yielders (SV40 was recovered in less than 50% of the trials) and five lines were rare virus yielders (SV40 recovered only once in four or more trials). Forty-eight mKS-U lines were nonyielders; SV40 was never recovered by any test used thus far. uv-Sendai-treated mixtures of pairs of nonyielder mKS-U lines with CV-1 cells also did not yield infectious virus. Various factors affecting rescue were discussed. The mKS-U lines that were poor virus yielders, rare yielders, or that never yielded virus were classified tentatively as defective lysogens that contain mutational lesions at loci essential for detachment of SV40 from integration sites or for SV40 replication, or for both. (auth)

928 EFFECTS OF ULTRAVIOLET RADIATION ON RESPIRATION AND GROWTH IN RADIATION-RESISTANT AND RADIATION-SENSITIVE STRAINS OF ESCHERICHIA COLI B. Hamkalo, Barbara A.; Swenson, P. A. (Univ. of Massachusetts, Amherst, Oak Ridge National Lab., Tenn.). J. Bacteriol., 99: 815-23(Sept. 1969).

Ultraviolet (uv) irradiation at 254 nm causes different respiration and growth responses in log-phase cultures of Escherichia coli B/r and B_{s-1}. These differences are correlated with the ability and inability, respectively, of these bacterial strains to repair uv-induced lesions in deoxyribonucleic acid (DNA). After irradiation, B_{s-1} cells (radiation-sensitive) exhibit uncoupling of growth and respiration; growth and synthesis cease, whereas respiration continues. B/r cells (radiation-resistant) grown on glycerol exhibit severe temporary inhibition of growth and respiration after uv, and the coupling of these two processes is maintained, except at a very high uv dose. Inhibition begins at about the time DNA synthesis resumes and continues for a period of time that is dependent upon dose. Glucose-grown cells do not exhibit severe respiratory, growth, and synthetic inhibitions; these processes remain coupled in the cells during the postirradiation period. Photoreactivation treatment delays uncoupling of growth and respiration in B_{s-1} and prevents inhibition of respiration and growth in B/r. These results indicate that the postirradiation responses result from the presence of pyrimidine dimers in DNA. Ultraviolet irradiation of B/r and B_{s-1} cells results in an accumulation of adenosine triphosphate by 30 min after uv. This accumulation decreases with time and does not appear to be related to the inhibition of respiration in glycerol-grown B/r cells. The results on B/r are interpreted in terms of a control mechanism for reestablishment of a balance among macromolecules in the irradiated cells so as to provide them with the potential to survive. The specific steps in such a reestablishment of balance appears to depend upon the substrate oxidized. In B_{s-1} cells, that cannot repair uv-induced damage in DNA, some control mechanism that coordinates cellular processes may be inactivated. (auth)

929 THE INFLUENCE OF MITOMYCIN C, ACTINOMYCIN D, AND ULTRAVIOLET LIGHT ON THE REPLICATION OF THE VIRUSES OF FOOT-AND-MOUTH DISEASE AND VESICULAR STOMATITIS. Black, D. N.; Brown, F. (Animal Virus Research Inst., Pirbright Eng.). J. Gen. Virol., 3: 453-7(Dec. 1968).

Foot-and-mouth disease virus (type 0) and vesicular stomatitis virus (type Indiana) were grown in monolayers of baby hamster kidney (BHK) cells and assayed by the plaque method. Monolayers of BHK cells were pretreated with different concentrations of mitomycin C for 8 hr, then infected, and the virus yield at 200 min (foot-and-mouth disease virus) or 300 min (vesicular stomatitis virus) determined. The yield of foot-and-mouth disease virus was depressed by 90% with 75 μg mitomycin C/10^7 cells and 99% with 150 μg/10^7 cells. By comparison the replication of vesicular stomatis virus was only slightly affected; with 150 μg/10^7 cells, for example, the yield was depressed by 30%. Replication of foot-and-mouth disease virus was unaffected by 10 μg actinomycin D/10^7 cells but suppressed at higher levels. Replication of vesicular stomatitis virus underwent a slight stimulation with actinomycin D, 10 to 20 μg/10^7 cells. BHK cell monolayers were irradiated with uv light, by a Hanovia Chromatolite cold cathode discharge lamp (with filters to restrict the wavelength to 2540 Å). Short periods of irradiation stimulated the replication of vesicular stomatitis virus. Irradiation of BHK cells caused a suppression of both cellular RNA synthesis and cellular protein synthesis. The viability of BHK cells (as measured by trypan blue exclusion) after treatment with mitomycin D, actinomycin D, and uv light was unaffected. Irradiation suppressed the replication of both viruses by comparable amounts (90%). Under the conditions of uv irradiation used, both cellular RNA synthesis and cellular protein synthesis were depressed. These results indicate that cellular RNA synthesis (i.e., DNA transcription) is required for some step in the replication of foot-and-mouth disease virus and that this step occurs within 45 to 60 min of infection. (BBB)

930 GENETIC AND PHYSIOLOGICAL STUDIES OF A LARGE-CELL STRAIN OF ESCHERICHIA COLI. Kvetkas, Marilyn Jean. Chicago, Illinois Inst. of Tech., 1969. 191p.

Thesis.

A genetic and physiological study of Escherichia coli P6 was undertaken in an attempt to determine its genetic constitution. E. coli P6 was isolated by Ogg and Zelle after camphor treatment of E. coli 82/r, an adenine-dependent derivative of E. coli B/r. It was not clear whether E. coli P6 originated as the result of a ploidy increase or as the consequence of a mutational event. The first part of this study consisted of a genetic analysis of the P6 (designated here as Lar⁻) phenotype. Reciprocal conjugal mating of E. coli P6 and wild-type E. coli B/r strains indicated that the P6 gene (lar-1) was located in the lower left-hand quadrant of the E. coli linkage map and was closely linked to strA. Finer mapping was achieved through use of the generalized transducing bacteriophage, P1bt. Crosses between E. coli P6 (carrying lar-1) and E. coli B47 (carrying argG) yielded a 95% cotransduction of lar-1 with argG. Thus, the lar-1 site is located at minute 61 ± 0.5 on the E. coli linkage map. Both conjugal and transductional recombinants were identified with either one or the other parent, with no indication of an intermediate class. This suggested that only a single mutant gene was responsible for the Lar⁻ phenotype. The second part of the investigation consisted of a comparative, physiological study of E. coli P6 and 82/r. Minimal M9 salts were supplemented with glucose plus additional nutrients, glucose alone, succinate or acetate to give four different growth rates. The mean cell volumes, the total amount of deoxyribonucleic acid (DNA), the number of nuclear bodies, and the x-ray responses of exponentially-growing cells of the two strains were determined as functions of the growth rate. Calculations based on these data showed that minimal P6 cells were approximately three times larger, contained about two and one-half times more DNA and, on the average, one and one-third times more nuclear bodies than minimal 82/r cells. From this, the nuclear bodies of P6 cells each appeared to contain twice as much DNA as those of 82/r cells. All of the x-ray survival curves for P6 cells were sigmoidal, gave extrapolation numbers of about two, and had smaller limiting slopes than the exponential survival curves obtained for 82/r cells. Other experiments indicated that P6 cells were not more efficient than 82/r cells in their repair of x-ray damage. These results suggested that the greater x-ray resistance and, presumably, the various other properties of P6 cells were due to the doubled DNA content of their nuclear bodies. Thus, E. coli P6 may represent the bacterial equivalent of a diploid cell; the diploidy being due to the action of a mutant gene. (auth)

Radiosterilization and Radiopreservation

931 (COO-1592-35) IRRADIATION OF FRUITS AND VEGETABLES. Annual Report, April 16, 1967–April 15, 1968. Markakis, P.; Nicholas, R. C. (Michigan State Univ., East Lansing. Dept. of Food Science). Oct. 1969. Contract AT(11-1)-1592. 62p. Dep. CFSTI.

The second year of research at Michigan State University concentrated on the study of the irradiated effects on five commodities: asparagus, mushrooms, peaches, strawberries, and sweet cherries. A 10,000 Ci cobalt-60 γ source used during the first part of the year was replaced by a 50,000 Ci cobalt-60 source for the remainder of the period. Results with asparagus showed that a 10 krad dose inhibited the lengthening of spears to the same extent as 30 and 100 krad doses; slightly less water was contained after irradiation; no change occurred in fiber plus ash content during storage as a result of irradiation; and an undesirable odor developed in irradiated spears after 11 days storage at 10°C. Results with mushrooms showed that irradiation retarded the rate at which white cultured mushrooms opened during storage; retardation of the rate of increase in cap diameter and rate of veil break was shown at a 10 krad dose (higher doses further decreased the rate of cap opening, but in a less than proportional way); mushroom height was enhanced by 10 to 20 krad, but retarded by 100 krad; texture and weight loss was not affected up to 100 krad; 50 krad or more caused less darkening; and the delay time between harvest and irradiation was related to shelf-life extension. Results with peaches showed that preirradiation water-dip treatment did not improve keeping quality; heating alone caused some softening, but radioinduced softening was more severe than that induced by heat. Results with strawberries showed inconsistent results for combined treatment with calcium soaking, but irradiation plus soaking gave less spoiled fruit than soaking alone. Results with sweet cherries showed that preirradiation water-dip treatment did not improve keeping quality; heating alone did not result in softening in contrast to irradiation; softened cherries refirmed during storage at 9°C. (C.O.)

932 STERILIZATION AND COMPETITIVE ABILITY OF γ STERILIZED MALES TO NORMAL MALES OF DACUS ZONATUS (SAUNDERS). Qureshi, Z. A.; Bughio, A. R. (Atomic Energy Agricultural Research Centre, Tandojam, Pakistan). Int. J. Appl. Radiat. Isotop., 20: 473-6(June 1969).

This species of fruit fly is a serious pest of woody fruit trees in Pakistan; conventional control methods are not effective, but it is considered that the sterile male technique shows great promise. For the successful application of this technique it is necessary to determine a radiation dose at which the flies become sterile, but otherwise remain healthy and vigorous in their mating behavior. From the experimental work described it was concluded that a dose of 9 kR is realistic to achieve this object. It is pointed out, however, that the studies were made using laboratory cages; studies should be carried out under field conditions. (auth) (UK)

933 EXPERIMENTAL ALLOPLASTIC REPAIR OF THE SKIN DEFECTS. Novak, J.; Pazonyi, T.; Dallos, Gy. (Health Service of the Hungarian People's Army, Budapest). Acta Chir. Acad. Sci. Hung., 10: 115-24(1969). (In German).

The use of radiation-sterilized plastic materials to repair skin wounds in rats and rabbits is described. The materials were washed in aqueous propylene glycol solution and dried. They were placed in polyethylene foil packages and treated with ^{60}Co γ irradiation at a dose of 2.5 MR. Polyvinyl alcohol and polyurethane foam sponges were applied to the skin defects that were created in the animals. Connective tissue was not found to have invaded the sponges. Although the alloplastic grafts were attached to the wound base by the serum, no true adhesion was observed. By use of materials with large pores and by greater softening of the sponges, they could be made to remain on the wound base for long periods. (BBB)

934 INCORPORATION OF LYOPHILIZED AND RADIO-STERILIZED PERFORATED AND UNPERFORATED BONE GRAFTS IN DOGS. Tarsoly, E. (Medical Univ., Debrecen, Hungary); Ostrowski, K.; Moskalewski, S.; Lojek, T.; Kurnatowski, W.; Krompecher, St. Acta Chir. Acad. Sci. Hung., 10: 55-63 (1969).

The acceptance and incorporation, as well as the osteogenic effect, of freeze-dried and radiosterilized perforated and unperforated compact bone grafts were studied. Specimens measuring 20 × 5 × 2.5 cm were prepared as follows. They were excised from the femoral bone of adult dogs, cleaned, and the periosteum removed. Then, in each specimen, numerous holes of 1-mm dia were drilled. One such perforated and one unperforated bone fragment were placed in vials, refrigerated at −79°C, and lyophilized. Then the vials were filled with nitrogen, stoppered and irradiated with ^{60}Co γ rays. The dose used for sterilization was 2.5 MRad. Bacteriological tests were negative. In the 10 recipient dogs a defect extending into the medullary cavity was created in both proximal epiphyses of the tibia, and one perforated and one unperforated fragment was grafted into each. From the results it was concluded that lyophilized compact bone grafts sterilized by γ irradiation are accepted and incorporated by the host. Such grafts had a good osteogenic effect since they underwent rapid absorption and were substituted by new bone. The rate of reconstruction of the compact bone was accelerated if the grafts were perforated. The perforations facilitated the ingrowth of vessels and replacement of the graft. Such increase of the surface area accelerated bone absorption and formation of new bone tissue and bone marrow. (BBB)

935 USE OF γ RADIATION FOR THE STERILIZATION OF INSECT PESTS OF AGRICULTURAL CROPS. Andreev, S. V.; Martens, B. K.; Molchanova, V. A.; Saldan, L. N. (All-Union Inst. of Plant Protection, Leningrad). Radiobiologiya, 8: 742-6(1968). (In Russian).

The development of methods using radiation sterilization to control insect pests of agricultural crops is discussed. On the basis of the investigations conducted, the principles of hatching of bean beetles of the new generation as a function of the dose of γ irradiation used during sterilization, as well as of the numerical ratio of sterilized beetles to unsterilized individuals of the natural population, were derived. (JPRS)

936 COMBINED HEAT-RADIATION TREATMENTS TO CONTROL STORAGE ROTS OF SPADONA PEARS. Ben-Arie, Ruth; Barkai-Golan, Rivka (Volcani Inst. of Agricultural Research, Bet-Dagan, Israel). Int. J. Appl. Radiat. Isotop., 20: 687-90(Oct. 1969).

Heat and radiation treatments interacted synergistically in the inactivation of spores of Penicillium expansum, Botrytis cinerea, and Alternaria tenuis. Decay of Spadona pears inoculated with P. expansum was almost completely prevented by treatment in hot water (47° C/7 min) followed by γ irradiation (50 krad). The same treatment did not prevent the rotting of fruits inoculated

with B. cinerea and A. tenuis but a delay in disease development was observed. (auth)

937 IDENTIFICATION OF IRRADIATED STRAWBERRIES. Natarajan, A. T.; Kim, Ch.; Loefroth, G. (Univ. of Stockholm). Int. J. Appl. Radiat. Isotop., 20: 614-15(Aug. 1969).

In order to forestall unintentional marketing of irradiated strawberries in countries which have not cleared this product for human consumption, methods are needed which can detect if a sample of strawberries has been irradiated. Such a method is described. This is based on cytological abnormalities in the cells of the primary roots of germinating seeds. (auth)(UK)

938 EFFECTS OF X IRRADIATION ON ADULT MALES OF THE FRUIT LEAF-ROLLER ADOXOPHYES RETICULANA Hb. (LEPIDOPTERA, TORTRICIDAE) WITH RESPECT TO GENETIC PEST CONTROL. Fransz, H. G. Neth. J. Zool., 19: 287(June 1969).

The percentage hatching of eggs obtained in pot experiments with Adoxophyes reticulana could be expressed by 80 to 5.5 · D, where D equals the irradiation dose in kRad received by the male parent, and $0 < D < 14$. The progeny of irradiated males (doses of 10 and 14 kRad) proved to be highly sterile and predominantly male. Control by release of sterile males is restricted by the condition that the sterilized males retain their copulating capacity and can compete with normal males in the population. Combinations of irradiated (14-kRad) and normal males together with females resulted in reproduction decreases resembling those expected when competition is unaltered. (BBB)

939 FOOD STERILIZATION BY MICROWAVE RADIATION. Bilbrough, J. (Microwave Instruments Ltd., Shiremoor, Eng.). Non-Ioniz. Radiat., 1: 70-2(Sept. 1969).

Normal methods of sterilization are briefly compared with the effect of microwave processing whose main objective is to kill mould spores on the inside of wrapping materials. A number of design features of suitable equipment are described with particular reference to prevention of stray radiation. (auth) (UK)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstracts 257, 359, 402, 403, 405, 408, 409, 455, 465, 476, 1063, and 1064.

940 (AI-AEC-12817) FUELS, MATERIALS, AND COOLANT CHEMISTRY PROGRAMS. Quarterly Technical Progress Report, January–March 1969. (Atomics International, Canoga Park, Calif.). Contract AT(04-3)-701. 97p. Dep. CFSTI.

Research progress on fuel and cladding materials is reported in sections devoted to tasks associated with materials management, the effects and failure mechanisms, mechanical properties in static and dynamic Na, mixed carbide properties and radiation effects, Na chemistry, and chemistry of fission product-contaminated Na. (J.R.D.)

941 (GEMP-1012(Pt.2)) AEC FUELS AND MATERIALS DEVELOPMENT PROGRAM. Eighth Annual Report. (General Electric Co., Cincinnati, Ohio. Nuclear Systems Programs). Mar. 31, 1969. Contract AT(40-1)-2847. 369p. Dep. CFSTI.

Research and development progress is reported in seven sections. A separate abstract was prepared for each section. (J.R.D.)

For abstracts of individual sections see: 948, 949, 966, 967, and 988–990.

942 MATERIALS DATA BOOK. For Engineers and Scientists. Parker, Earl R. New York, McGraw-Hill Book Company, 1967. 411p. $8.95.

A compilation of engineering information for use as a source of design data for metals, alloys, wood, ceramics, concrete, and plastics, is presented. Information on mechanical properties is stressed and data on density, specific heat, electric and thermal properties are included. (J.R.D.)

943 MOLIBDEN I VOL'FRAM. (Molybdenum and Tungsten). Perel'man, F. M.; Zvorykin, A. Ya. Moscow, Izdatel'stvo Nauka, 1968. 144p.

Properties of molybdenum and tungsten and their chemical compounds with other elements (oxygen, sulfur, and halides) are reviewed. Compounds with nitrogen, boron, carbon and silicon are also reviewed. Physicochemical analysis is given of binary Mo and W alloys with Al, Be, Cr, Co, Fe, Nb, Ni, Ta, Va and metals of platinum group and rhenium. Molybdates and tungstates in salt and aqueous solutions are discussed as well as the quantitative and qualitative analyses and determination in ores and industrial products. Methods used for extraction of Mo and W from minerals and preparation of metallic molybdenum and tungsten are described. 304 references. (R.V.J.)

944 RECENT DEVELOPMENTS IN ELLIPSOMETRY. Proceedings of the Symposium, Lincoln, Nebraska, August 7–9, 1968. Bashara, N. M.; Buckman, A. B.; Hall, A. C. (eds.). Surface Sci., 16: 1-452(Aug. 1969). (CONF-680840).

Thirty-six papers were presented at the conference. An abstract was prepared for one paper. Papers for which no abstracts were prepared are concerned with ellipsometric computation, methods and instruments for ellipsometry, field effects on ellipsometry, ellipsometric studies of filmed surfaces, and other applications of ellipsometry. (J.R.D.)

For an abstract of the individual paper see: 1021.

945 Zr Hf NEWSLETTER, OCTOBER 1969. Akron, N. Y., AMAX Specialty Metals Division, 1969. 14p.

Development and applications of Hf and Zr and their alloys are summarized. Information on production is included along with a bibliography of 152 references. (J.R.D.)

Corrosion and Erosion

Refer also to abstracts 181, 995, 1060, and 1309.

946 (AECL-3375) ON THE OXIDATION OF ZIRCONIUM ALLOYS IN AIR AND THE DIMENSIONAL CHANGES ASSOCIATED WITH OXIDATION. Watson, R. D. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). June 1969. 64p. Dep. CFSTI (U. S. Sales Only). CAN $1.50.

The oxidation rates for zirconium, Zircaloy-2, Zircaloy-4, Zr 2½ wt % Nb, and Zr–Ti alloys containing titanium in amounts ranging from 0.05 to 10 wt % were determined in air at temperatures in the range from 375 to 800°C. The effects of different surface preparations such as shot-blasting, polishing, and machining on the oxidation rates were investigated for some of the alloys. The dimensional changes associated with oxidation at the different temperatures were determined for several of the alloys using specimens made of sheet, tubing, or bar stock. The effects of wall thickness and oxidation temperature on the dimensional changes of several of the alloys during oxidation were also investigated. Thin walled tubes were internally pressurized during oxidation to determine the relations between hoop stress and circumferential strain. The oxidation rates of Zircaloy-2 in air at 500 and 650°C, and dilute Zr–Ti alloys in air at 650 and 800°C are extremely dependent on the method used in preparing the surface. The oxidation rates of Zr 2½ wt % Nb at 500 and 650°C and Zr 10 wt % Ti at 400°C are less dependent. The oxidation rates of dilute Zr–Ti alloys in air at 650 and 800°C increase with increasing titanium content. The diameter and/or length change that occurs during the formation of a given oxide thickness on many of the zirconium alloys increases with increasing oxidation temperature. For Zircaloy-2 and Zr 10 wt% Ti the lengthening of the material during the formation of a given oxide thickness, although not inversely proportional to wall thickness, is greatest when the wall is thinnest. Most of the volume increase associated with the oxidation of Zircaloy-2 and Zr 10 wt % Ti goes to thicken the wall. On the other hand most of the volume increase associated with the oxidation of Zr 2½ wt % Nb at 650°C in air goes to stretch the material. The plastic strain rate of Zircaloy-2 tubing during oxidation in air is increased considerably when the tubing is pressurized internally. (auth)

947 (BNWL-1035) ESTIMATE OF THE FATIGUE CRACKING BEHAVIOR OF THE FAST TEST REACTOR PRIMARY PIPING. Schwenk, Earl B.; James, Lee A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 1969. Contract AT(45-1)-1830. 89p. Dep. CFSTI.

The concepts of linear elastic fracture mechanics are applied to the FTR primary piping. Estimates are made of fatigue crack propagation behavior for service conditions, and crack length versus cycles information is established. (auth)

948 (GEMP-1012(Pt.2), pp 203-52) PHYSICOCHEMICAL STUDIES OF CLAD UO_2 UNDER REACTOR ACCIDENT CONDITIONS. White, J. F. (General Electric Co., Cincinnati, Ohio. Nuclear Systems Programs).

Activities in a program to determine the behavior of Zircaloy-clad UO_2 fuel elements in steam and in steam–air mixtures from 1000°C to the melting point of UO_2 are summarized. These studies include measurement, where necessary, of the pertinent physical and mechanical properties of the cladding, the oxidized cladding, and UO_2 to their respective melting points. Testing was continued to determine the combined effects of internal pressure, heating rate, and steam oxidation on the deformation and failure characteristics of Zircaloy-4. Tests were initiated to determine the effects of radiation damage on pressurized tubes under dynamic conditions Studies on the phase relationships and melting behavior in the UO_2–Zr pseudobinary system were started. Spectral and total hemispherical emittance measurements of oxidized Zircaloy-4 were continued and a procedure was developed for estimating the total hemispherical emittance as a function of time and temperature as the oxide film grows during oxidation in steam. The studies of the high-temperature yield properties of Zircaloy-4 were also continued. Equipment was assembled to study the effect of high oxygen content on the room- and intermediate-temperature ductility of Zircaloy-4. (auth)

949 (GEMP-1012(Pt.2), pp 311-64) FAST BREEDER REACTOR CONTROL, SHIELD, AND REFLECTOR MATERIALS DEVELOPMENT. Van Houten, G. R.; Kennedy, M. D.; Duderstadt, E. C. (General Electric Co., Cincinnati, Ohio. Nuclear Systems Programs).

A new diffusion couple test specimen design was developed, evaluated, and found acceptable. The design incorporates a hermetically sealed, thin-walled cylinder of the cladding alloy filled with alternating layers of neutron absorber discs and cladding alloy wafers of varying thicknesses to permit identification of reservoir related diffusion-couple effects. The capsule is then maintained at external pressures of as much as 2 8 kg/mm² to ensure continuing firm contact of uncontaminated diffusion couple interfaces. Four high-pressure test furnaces, each capable of providing identical pressure–temperature exposures to from 50 to 150 test specimens, have been made available to this program. More than 100 diffusion couple test specimens were fabricated and placed on test at test

temperatures of 400 (2.8 kg/mm^2), 600 (2.8 kg/mm^2), 800 (2.1 kg/mm^2), 1000 (0.42 kg/mm^2), and 1200°C (0.7 kg/mm^2). Test specimen compositions include: B_4C vs 316 SS, BN vs 316 SS, Ta vs 316 SS, and Ta vs Mo. Preliminary BN–316 SS diffusion couple test specimens showed excellent stability. Preliminary Ta–Mo diffusion couple test specimens showed excellent stability. Since Ta and Mo have substantially equal thermal coefficients of expansion, Mo-clad Ta is expected to exhibit excellent operational stability. A GE-owned 304 SS liquid-metal test loop has been made available to determine the stability of Mo-clad Ta control elements in this environment. (auth)

950 (ORNL-tr-2211) STUDIES ON THE COMPATIBILITY OF URANIUM MONONITRIDE WITH MOLYBDENUM, TUNGSTEN, AND THORIUM OXIDE AT HIGH TEMPERATURES. Politis, G.; Thuemmler, F.; Wedemeyer, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material und Festkoerperforschung). Translated by R. L. Beatty (Oak Ridge National Lab., Tenn.), from report KFK-885. 16p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 27140.

951 CONTAMINATION OF REACTIVE METALS IN VACUUM HEAT TREATING AT VARIOUS VACUUM LEVELS. Bunshah, R. F. (Univ. of California, Livermore). pp 611-19 of Transactions of the International Vacuum Metallurgy Conference. Barrow, R. B. (ed.). New York, American Vacuum Society, 1968.

From Vacuum Metallurgy Conference, Beverly Hills, Calif. See CONF-680623.

The contamination of thin (0.002 in. thick) tantalum foil during exposure to vacuums of 10^{-6} and 10^{-10} torr at elevated temperatures was investigated. Tungsten sheets 0.050 in. thick and a cylindrical creep specimen 0.125 in. in diameter were also exposed. The specimens were analyzed for hydrogen, oxygen, and nitrogen by vacuum fusion techniques, and for carbon by combustion methods before and after exposure. During a vacuum exposure at 4×10^{-6} torr at 1800°C, significant contamination of Ta with oxygen occurred in a short time. Contamination by C, H, and N was minor. During exposure at 2×10^{-10} torr and 1400°C, no measurable contamination occurred. Tungsten was not contaminated over the pressure range 4×10^{-6} to 2×10^{-10} torr presumably because of a dynamic balance between the contaminating and purifying reactions. Tantalum foil is an excellent passive monitor of the contamination during a long vacuum exposure. It should be included routinely in long creep exposures and analyzed for C, H, N, and O after exposure. (J.C.W.)

952 CONTAMINATION OF TANTALUM AND TANTALUM ALLOYS IN LOW PRESSURE OXYGEN ENVIRONMENTS. Harrison, R. W.; Hoffman, E. E. (General Electric Co., Cincinnati). pp 29-57 of Transactions of the International Vacuum Metallurgy Conference. Barrow, R. B. (ed.). New York, American Vacuum Society, 1968.

From Vacuum Metallurgy Conference, Beverly Hills, Calif. See CONF-680623.

A knowledge of the reactivity of oxygen with refractory alloys is a requirement to determine the environmental conditions necessary for long term testing of refractory alloy components or systems at elevated temperatures. Oxygen contamination of refractory alloys during testing may cause a deleterious change in mechanical properties and destroy the corrosion resistance of the refractory alloy to alkali metals. The contamination of tantalum and tantalum alloys of present interest for usage in large space power systems was investigated over the oxygen pressure range from 1×10^{-5} to 5×10^{-7} torr at a temperature of 2400°F. Under these conditions oxygen is absorbed into the refractory alloys without the formation of surface oxides. Sheet specimens of tantalum, T-111 alloy (Ta–8W–2Hf), ASTAR 811 alloy (Ta–8W–1Hf–1Re), ASTAR 811C alloy (Ta–8W–1Hf–0.7Re–0.025C), and ASTAR 811CN alloy (Ta–8W–1Hf–1Re–0.012C–0.012N) were heated by direct resistance in a 24-inch diameter by 90-inch high getter ion pumped Varian high vacuum chamber. Usage of a large cold wall chamber is believed to give an accurate simulation of the oxygen contamination that may be anticipated in component or system testing in similar chambers. The chamber was evacuated to 1×10^{-9} torr before introducing oxygen through a leak valve to maintain the desired pressure. In this manner, and by monitoring the gas species in the chamber with mass spectrometric techniques, oxygen partial pressures in the range specified were maintained for periods up to 100 hours. Contamination rates and sticking factors are presented for each alloy. The lattice parameter of tantalum as a function of oxygen concentration is also presented. (auth)

953 PROBLEMS OF CORROSION UNDER STRESS IN NUCLEAR INSTALLATIONS. Coriou, H. (CEN, Saclay, France). Bull. Inform. Sci. Tech. (Paris), No. 139, 3-17(July-Aug. 1969). (In French).

The wide use of austenitic steels in nuclear installations (reactors and irradiated fuel processing plants) involves the risk of stress corrosion cracking. Problems caused by the various media which may be encountered both in the reactors (pure, chlorinated, or alkaline water) and in the plants (sulfuric solutions) are investigated. A description is given of incidents which have occurred; the various possible remedies are reviewed. The mechanisms involved are also considered. (auth)

954 NICKEL-BASED ALLOYS AND STAINLESS STEEL STUDY OF THEIR CORROSION RESISTANCE PROPERTIES IN SUPER-HEATED STEAM. Grall, L. (CEN, Saclay, France). Bull. Inform. Sci. Tech. (Paris), No. 139, 19-30(July-Aug. 1969). (In French).

A study was made of the corrosion behavior of iron–chromium–nickel austenitic alloys in water vapor at 600°C, as a function of the nickel, silicon, molybdenum, and chromium contents. It is shown in particular, which are most favorable compositions from the point of view of the resistance to oxidation. It is also shown that a nickel-rich alloy of the Inconel 600 type is subjected to intergranular cracking when under stress in steam at 600°C. (auth)

955 STUDY OF THE BEHAVIOR OF STAINLESS STEELS IN IRRADIATED FUEL PROCESSING PLANTS. Pelras, M. (CEN, Saclay, France). Bull. Inform. Sci. Tech. (Paris), No. 139, 31-46(July-Aug. 1969). (In French).

Factors are discussed which can lead to a decrease in the corrosion resistance of stainless steels during processing of irradiated fuels carried out in hot nitric solutions. (auth)

956 EFFECTS OF IRRADIATION ON THE OXIDATION AND THE HYDROGEN UPTAKE OF ZIRCONIUM ALLOYS IN WATER AT HIGH TEMPERATURES STUDY OF THE ALLOY BEHAVIOR IN SUPERHEATED STEAM. Blanchet, J. (CEN, Saclay, France). Bull. Inform. Sci. Tech. (Paris), No. 139, 47-58(July-Aug. 1969). (In French).

A description is given of the corrosion behavior of Zircaloy-2 fuel element cans in various water-cooled reactors and which have been in operation for several years. A review is made of certain research projects designed to study the effects of irradiation on the corrosion of zirconium alloys. It appears certain that only fast neutrons enhance the corrosion, and this to an extent which depends on the flux intensity and on the oxygen content of the water. The most important research concerning the development of zirconium alloys for use in superheated steam is reviewed. Several alloys have, in this medium, a much better corrosion resistance than Zircaloy-2. (auth)

957 ZIRCONIUM ALLOYS RESISTANT TO CARBON DIOXIDE AT HIGH TEMPERATURE. Darras, R.; Loriers, H.; Baque, P.; Berry, J. L. (CEN, Saclay, France). Bull. Inform. Sci. Tech. (Paris), No. 139, 59-72(July-Aug. 1969). (In French).

The addition of copper, in concentrations varying between 1.6 and 3% by weight, delays—or even abolishes—the increase in oxidation rate which systematically begins to affect zirconium and most of its other alloys after exposure in carbon dioxide at about 525°C; this prevents their long-term use at higher temperatures. The surface of these copper-containing alloys retains a relatively uniform layer of zirconia, and the development of cracks is also limited. The optimum copper content is 2.5% from the viewpoint of corrosion, and this superiority is particularly marked at temperatures above 600°C. The influence of various factors such as the presence of impurities in the gas phase, heat cycles, stresses, neutron irradiation, and the addition of other elements is described. In particular, when the carbon dioxide contains small quantities of water vapor the hydrogen absorption drops as the copper content of the alloys increases. (auth)

958 PROTECTION OF ZIRCONIUM AND ITS ALLOYS AGAINST OXIDATION AT HIGH TEMPERATURE. Loriers, H.; Lafon, A.; Darras, R. (CEN, Saclay, France). Bull. Inform. Sci. Tech. (Paris), No. 139, 73-82(July-Aug. 1969). (In French).

The corrosion of zirconium in carbon dioxide between 600 and 700°C has been very much reduced and even abolished by means of protective metal coatings. Aluminum coatings obtained by vacuum deposition, followed by a consolidation heat treatment, prevent the formation of the zirconia layer but not the hardening of the support by oxygen diffusion. On the other hand, electrolytic chromium deposits, made more adherent by a vacuum heat treatment, eliminate both these phenomena. A similar result was obtained with molybdenum coatings. The special effectiveness of the two last types of coating is due to their make-up, characterized by the subsistence of an adherent film of free chromium or molybdenum. (auth)

959 CORROSION OF STEELS AND IRON–CHROMIUM–NICKEL ALLOYS BY LIQUID SODIUM. Champeix, L.; Cornec, G.; Sannier, J. (CEN, Saclay, France). Bull. Inform. Sci. Tech. (Paris), No. 139, 83-96(July-Aug. 1969). (In French).

Following a few general remarks on the mechanisms of corrosion by liquid metals, which are noticeably different from those met in more conventional media, the problems connected with the use of the various categories of material considered are examined briefly. Austenitic steels are commonly considered to be reasonably resistant to liquid sodium so long as the oxygen content of the latter is kept sufficiently low. However there is some controversy over the fundamental corrosion process, and the kinetics of the phenomenon are thought to differ. Ferritic steels behave similarly if they contain enough chromium to lessen the tendency toward decarburization. (auth)

960 FINAL EVALUATION OF SHIPPINGPORT POWER STATION'S STAINLESS STEEL GENERATOR AFTER FIVE YEARS. Welinsky, I. H. (Westinghouse Electric Corp., West Mifflin, Pa.); Brindley, W. F.; Berry, W. E.; Whirl, S. F. pp 1-13 of High Purity Water Corrosion of Metals. Houston, Tex., National Association of Corrosion Engineers, 1968.

From 23rd Annual Meeting of the National Association of Corrosion Engineers, Los Angeles, Calif. See CONF-670312.

The original four steam generators used for more than five years in the Shippingport plant were tubed with Type 304 stainless steel. Leaks developed in the 1B unit after only a short period of operation. Reports of an investigation at that time lead to the conclusion that a combination of free caustic in the boiler water and a prevailing concentration mechanism caused the transgranular cracking observed in removed sections of tubes. The same 1B unit, removed from the plant after over five years' service, has now been subjected to a complete destructive examination. The condition of the unit and the boiler water control used is described. Widespread cracking was found in the tubes. The cracks were intergranular in the sensitized sections and transgranular in the annealed sections. Although the cracking could be attributed to either chloride or caustic stress corrosion, the evidence points to caustic as the more probable cause. Most of the cracking apparently occurred during the initial 150 hours of operation when the boiler water contained free caustic. Seventeen of 31 typical tubes from the 1B unit, when examined in detail, showed perforations. Trisodium and monosodium phosphate were used to adjust pH rather than caustic soda; disodium phosphate was substituted for sodium pyrophosphate and phosphate concentration was increased. (auth)

961 INDUCTION OF CREVICE CORROSION IN REACTOR MATERIALS BY CONCENTRATION OF COOLANT ADDITIVES. Lechnick, W. (Westinghouse Electric Corp., West Mifflin, Pa.); Brown, P. E.; Schultz, B. G. pp 14-21 of High Purity Water Corrosion of Metals. Houston, Tex., National Association of Corrosion Engineers, 1968.

From 23rd Annual Meeting of the National Association of Corrosion Engineers, Los Angeles, Calif. See CONF-670312.

Tests performed with internally heated crevice corrosion test specimens, simulating possible Shippingport (PWR) reactor crevice geometries, show that non-volatile coolant additives could concentrate in boiling crevices, inducing accelerated corrosion. Chemical analysis of solutions instantaneously trapped in a boiling crevice show concentration factors of up to 1000 over a ten-day period. Rate of concentration is a function of both temperature and geometry. Results obtained from Zircaloy crevice corrosion testing performed at temperatures above T_{sat} are presented for different crevice geometries. A theory for the mechanism of concentration has been substantiated in part by experimental data. (auth)

962 DISPERSION OF CORROSION PRODUCTS FROM A FILM-FORMING METAL EXPOSED TO AN AQUEOUS STREAM. Bartlett, J. W. (Moffett Naval Air Station, Sunnyvale, Calif.); Kabele, T. J.; Mills, C. M. pp 22-34 of High Purity Water Corrosion of Metals. Houston, Tex., National Association of Corrosion Engineers, 1968.

From 23rd Annual Meeting of the National Association of Corrosion Engineers, Los Angeles, Calif. See CONF-670312.

Transport and dispersion characteristics of corrosion products from cold-rolled, mild steel exposed to flowing high purity water were investigated theoretically and experimentally. Flat-plate specimens with radioactive leading portions were exposed in a carefully controlled hydraulic regime to aerated, distilled water at a temperature of 145°F and Reynolds numbers in the range 1000 to 4400. Corrosion product accumulation as a function of position along the specimen was determined using ^{59}Fe as a tracer. By comparing a digital computer analysis of the rigorous equations and a simplified model to the data, results are shown to correspond to the transport equations that describe a process in which soluble species coagulate to form particulates. The data and analysis indicate that corrosion product mobilities are velocity dependent but very low in the range investigated. (auth)

963 ON THE INTERNAL AND EXTERNAL OXIDATION OF Cu–1 PERCENT Zr, Cu–0.5 PERCENT Ti, AND Cu–1 PERCENT Ti ALLOYS. Vasu, K. I. (Indian Inst. of Science, Bangalore). Curr. Sci. (India), 38: 477-80(Oct. 20, 1969).

Oxidation of Cu–1% Zr, Cu–0.5% Ti and Cu–1% Ti alloys in pure oxygen in the range of 600 to 900°C was generally governed by a linear rate law in the initial stage (which is very conspicuous with Cu–1% Zr alloy) and a parabolic rate law in the succeeding stage. The linear oxidation had a low activation energy of 9 kcal/mole and involves a phase-boundary process of chemisorption. The parabolic oxidation, controlled by the Cu^+ ion diffusion through the scaling layer, has a high activation energy of 30 kcal/mole. (auth)

964 A METHOD FOR THE PROTECTION OF ZIRCONIUM AND ITS ALLOYS AGAINST THE ABSORPTION OF HYDROGEN. Schleicher, Hans-Walter; Brossa, Francesco (to EURATOM). British Patent 1,169,098. Oct. 29, 1969. Priority date Aug. 12, 1966, Belgium.

Methods of protecting Zr and its alloys from hydrogen embrittlement are described. The metal surface to be protected is covered using aluminum–silicon solid solutions and heated at 400 to 650°C. A thin film interlayer of metal such as copper may be used. (J.R.D.)

965 THE EFFECT OF HEAT TRANSFER ON THE CORROSION BEHAVIOR OF TYPE 304 STAINLESS STEEL IN BOILING WATER. Steigerwald, R. F. (Climax Molybdenum Co., Pittsburgh). Contract AT(07-2)-1. Trans. Met. Soc. AIME, 245: 2175-80(Oct. 1969).

The effects of heat transfer on the corrosion behavior of Type 304 stainless steel in boiling water were studied. Heat transfer conditions increased the tendencies of the stainless steel toward stress-corrosion cracking when the water was contaminated with Cl^-. Surface preparation was the most important variable in determining the severity of the stress-corrosion problem in water with a given Cl^- content. Heat treatment, chemical cleaning, and degree of wet film boiling also affected the corrosion of stainless steels used as heat transfer surfaces in boiling water. An apparatus for corrosion testing under controlled heat transfer conditions is described. (auth)

Preparation and Fabrication

Refer also to abstracts 351, 995, 1029, and 1073.

966 (GEMP–1012(Pt.2), pp 13-39) PHYSICAL METALLURGY OF FAST BREEDER REACTOR CLADDING MATERIALS AND REFRACTORY METALS. Collins, C. G.; Bohlander, K. M. (General Electric Co., Cincinnati, Ohio. Nuclear Systems Programs).

Studies to define thermal-mechanical treatments yielding optimum ductility in LMFBR fuel-cladding alloys were conducted. Results of tensile tests at various strain rates at 650°C indicated two promising treatments in the 19-9DL alloy. Both treatments produce fine grain (~5 to 10 micron) material; one consists of 1 hour anneals at 1040 and 840°C following 60 to 80 percent cold reduction, and the other involved 980°C annealing following 30 percent reduction at –196°C. The double anneal treatment was used in combination with planetary swaging to produce tubes which meet the physical specifications (except length) set forth by the FFTF project. Initial creep tests of this fine grain tube material at 650°C indicated slightly higher strength and about one-third greater rupture ductility than normal Type 316 stainless steel tested under similar conditions. Removal of carbon impurities from molybdenum was studied in moist hydrogen and argon atmospheres using an improved carbon analysis procedure. In both atmospheres, carbon removal appeared to follow different reactions above and below 1400°C. In hydrogen containing 20 ppM H_2O, carbon removal was rapid at the higher temperatures, in sheet specimens 0.05 to 0.1 cm thickness, carbon concentrations of 265 ppM were reduced to 1 to 2 ppM in less than 1 hour at 1600°C or higher while 100 hours appeared necessary for the same reduction at 1200°C. Carbon reduction was slower in moist argon than in hydrogen and at temperatures above 1400°C the residual carbon concentrations after 2-hour exposures appeared related to carbon solubility. A study of variables influencing the weldability of molybdenum and W–Re–Mo alloys established that powder-metallurgy molybdenum compares favorably with a vacuum arc-cast molybdenum in terms of weld porosity and bend ductility. Optimum electron-beam welding

conditions for 0.4 to 0.6 mm sheet were found to be 90 kilovolts and 4 milliamps using a double pass technique, the second pass with the beam defocused, and a post-weld stress relief treatment. A wrought structure or fine grain size material yielded better welds than large grain size material while surface preparation, other than a requirement for good mating of the surfaces, did not appear critical at the purity level of NSP materials. In general, the results tended to confirm the existing opinions that oxygen is the most critical impurity influencing weld porosity and ductility, and some evidence was obtained indicating minor importance of carbon at concentrations up to about 250 ppM. (auth)

967 (GEMP-1012(Pt.2), pp 253-309) FAST BREEDER REACTOR THERMOCOUPLE DEVELOPMENT. Baxter, W. G.; Kuhlman, W. C. (General Electric Co., Cincinnati, Ohio. Nuclear Systems Programs).

The ORTC-II reactor test was completed and indicated that the effect of a 10^{21} n/cm^2 thermal neutron exposure on the calibration of a W versus W-25 Re thermocouple was less than calculated. This effect will be further reduced on a centerline fuel element thermocouple since the fuel and insulator (HfO_2-ThO_2) will further reduce the thermal neutron flux in the vicinity of the W and W-25 Re wires. Small diameter (1.118 mm OD) thermocouple insulator tubes with two holes (0.305 mm dia) 22.9 to 30.5 cm long were fabricated from BeO, HfO_2, and ThO_2 powders. Small-diameter W-25 Re (1.575 to 1.651 mm OD-0.203 mm wall) sheath materials were fabricated from metal powders to small diameter nugget tubes with wrought structure. An electrical resistivity rig was reactivated and the resistivity of single crystal alumina (99.9% pure) and morganite alumina (99.7% pure) was measured up to 1900°C. The higher-purity material indicated a higher resistivity value. An inpile test using a LMFBR reference fuel material (80 UO_2-20 PuO_2) was designed, fabricated, and installed in the ORR. The primary purpose of this test is to determine the chemical compatibility of W-25 Re and Re thermocouple sheath materials with mixed oxide fuels at 2300°C. The test is scheduled to operate 1000 hours. In support of test ORTC-III, a 1000-hour thermocouple calibration test was conducted using 0.229-mm-diameter W versus 0.229-mm-diameter W-25 Re wire mounted in HfO_2 insulator 1.118 mm OD with two 0.305-mm-diameter holes. The insulator was supported in a 1.575 mm OD-0.203 mm wall sheath tube of W-25 Re fabricated from powder. The thermocouple operated successfully throughout the test period although a shift in calibration in the order of 175°C was recorded at 2300°C. This calibration shift was the result of a reduction in the diameter of the W wire, an increase in the diameter in the W-25 Re wire through a vapor transport phenomena, the diffusion of Re and Mo into the W wire, and the dilution of Re in the W-25 Re wire. A thermal cycling test rig for evaluating the performance of 12.2-m-long type "K" thermocouple subjected to 650 to 315°C Δ T was designed, assembled, and operated. Three of the six test thermocouples (1.575 mm OD-MgO insulation) fabricated with ungrounded junction failed in the first 300 cycles. Extension of the thermal cycling test program on Type "K" thermocouples using a dynamic sodium coolant over a 9.14-m-long test section is planned during the next fiscal year. The design of such a loop has been completed and is being reviewed in detail. This type rig is capable of statistically evaluating the performance of commercial thermocouples. (auth)

968 APPLICATIONS AND CASE HISTORIES OF AN IN-PLANT VACUUM HEAT TREATING DEPARTMENT. Stewart, D. (IBM, San Jose, Calif.). pp 585-94 of Transactions of the International Vacuum Metallurgy Conference. Barrow, R. B. (ed.). New York, American Vacuum Society, 1968.
From Vacuum Metallurgy Conference, Beverly Hills, Calif. See CONF-680623.

The vacuum heat treating process for fabrication of production parts is described. This is accomplished in the vacuum heat treating department, which has two production vacuum furnaces. The production of several parts is discussed. Beryico 25 alloy sheets 4 × 10 × 0.004 in. thick are given the hardening treatment, the requirement being that the finished sheets be flat and bright. A 0.002 in. thick photo etched magnetic head lamination is given a 2050°F anneal to develop optimum magnetic properties. Erase core laminations are tiny annealed fragile parts. They are copper plated locally, and the anneal is done after plating to assure proper permeability. A unique racking method of the anneal of a 4-79 Molybdenum Permalloy is described. The brazed assembly lock screw requires two different local hardness levels and a brazed joint. The requirements are met by a single treatment in the vacuum furnace. An engineering change in hardness call-out of the one piece lock screw left an expensive inventory of obsolete parts, which were successfully reworked to the new criteria by a combination of vacuum heat treatments. (auth)

969 PRACTICAL VACUUM SINTERING OF METALS. Anderson, J. E. (Sintered Specialities, Jamesville, Wis.). pp 595-610 of Transactions of the International Vacuum Metallurgy Conference. Barrow, R. B. (ed.). New York, American Vacuum Society, 1968.
From Vacuum Metallurgy Conference, Beverly Hills, Calif. See CONF-680623.

The equipment, method, and economics of vacuum sintering are discussed, including development and production experience on a variety of metals. Vacuum furnace features that would lead to greater acceptance of vacuum sintering in the powder metal industry are listed. (P.C.H.)

970 PREPARATION OF ZIRCALOY STANDARDS SAMPLE FOR CHEMICAL COMPOSITION ANALYSIS. Kashu, S.; Nagase, M.; Hayashi, C.; Nakazima, T.; Takashima, K. (Japan Vacuum Engineering Co., Ltd., Yokohama). pp 553-77 of Transactions of the International Vacuum Metallurgy Conference. Barrow, R. B. (ed.). New York, American Vacuum Society, 1968.
From Vacuum Metallurgy Conference, Beverly Hills, Calif. See CONF-680623.

The preparation of Zircaloy sample usable as a standard for composition analysis by using a 120 kW electron beam skull furnace is described. Major elements (Sn, Fe, Ni, and Cr) and impurity elements, such as Al, Cu, Ti, Si, Co, B, and Hf, were observed before and after the skull casting. Three major elements (Sn, Fe, and Ni) in Zircaloy can be controlled to within ±10% of the respective preset level, provided each content in the skull has been previously controlled to within ±50% of a predetermined value. Chromium showed low and scattered yield. Composition analysis of major elements in upper, middle, and lower part of an ingot showed less than 4% deviation in Sn, 8% in Fe and Ni, and 11.1% in Cr from the average contents in the ingot. Impurity elements of B, Ti, Si, and Al in Zircaloy can be controlled to within ±15% of the preset level. Yields of Cu and Co were less than 20% and widely scattered results were obtained, even if the 120 kW rotated electron beam was used. Composition analysis of impurity elements in upper, middle, and lower part of the ingot showed less than 5.2% deviation in Ti and less than 10% in B, Si, Co, Cu, and Al from the average value of content for the respective element. In skull melting of the alloy, there is an active zone near the surface of the skull which reacts with the molten pool. For the control of Al or Ti content in Zircaloy the surface layer of the skull up to 5 mm in depth was estimated to be reactive. (auth)

971 PREPARATION AND EVALUATION OF RHENIUM AND RHENIUM-BASE ALLOYS. Armantrout, C. E.; Kato, H. (Bureau of Mines, Albany, Oreg.). pp 439-62 of Transactions of the International Vacuum Metallurgy Conference. Barrow, R. B. (ed.). New York, American Vacuum Society, 1968.
From Vacuum Metallurgy Conference, Beverly Hills, Calif. See CONF-680623.

To determine selected mechanical properties, pure rhenium and rhenium-base alloys consolidated by arc melting using nonconsumable electrodes were fabricated to sheet and rod. An optimum cold-working procedure was developed that utilized cold-press forging with reductions of up to 40 percent, annealing, and then cold rolling using multiple pass reductions to a total reduction of 20 to 30 percent between each anneal. The repeated cold working and annealing of cast rhenium ingots resulted in an appreciable increase in hardness from Rockwell A 42 to 43 to Rockwell A 58 to 62; however, no further hardening was noted with additional working and annealing steps. Tensile strengths were 109,000 to 130,000 psi, yield strengths 16,100 to 17,700 psi, and modulus of elasticity 54×10^6 psi for pure rhenium. The alloys that were amenable to cold working and that were subsequently tested in tension were of the solid-solution type or were amenable to heat treating in a solid-solution range. The alloy additions that strengthened through solid-solution mechanisms had high tensile strengths, up to 231,000 psi, yield strengths up to 119,000 psi with elongations near 20 percent, and modulus of elasticity of near 60×10^6 psi. (auth)

972 RECENT ADVANCES IN MASS PRODUCTION OF SPUTTERED TANTALUM FILM. Shirley, W. S. (Western Electric Co., Chicago). pp 251-62 of Transactions of the International Vacuum Metallurgy Conference. Barrow, R. B. (ed.). New York, American Vacuum Society, 1968.
From Vacuum Metallurgy Conference, Beverly Hills, Calif. See CONF-680623.

An open ended vacuum sputtering machine has been in production use for over two years. The vacuum design concepts of the facility, which were developed in 1963, are reviewed prior to a discussion of operating experience. Emphasis is placed on the developments which have been incorporated to adapt the basic machine for economical manufacturing using non-technical per-

sonnel. The machine was scheduled to operate approximately one-half of the normal work weeks during 1967 with an output in excess of two million square inches of nitrided tantalum film. (auth)

973 INVESTMENT CASTING OF REACTIVE METALS IN THE ELECTRON BEAM FURNACE. Stephan, H.; Sperner, F.; Dietrich, W. (Leybold-Heraeus GmbH, Hanau, Germany). pp 389-402 of Transactions of the International Vacuum Metallurgy Conference. Barrow, R. B. (ed.). New York, American Vacuum Society, 1968.

From Vacuum Metallurgy Conference, Beverly Hills, Calif. See CONF-680623.

With the increasing demand for precision castings made from reactive metals, the percentage of material to be recycled in the casting production rises subsequently too. The possibility of re-using this high-quality scrap is especially given in the electron beam furnace. The construction of the furnace, the electron beam gun, and the crucible is described. The different process parameters such as efficiency, power consumption and pressure, and the possibility of pool overheating and temperature control during the cast are defined. Castings of alloys were examined with regard to alloying components, mechanical properties and as-cast structure. The processes used in the reprocessing of titanium alloys and Zircaloy are discussed and the equipment described. The arc, electron beam, and plasma beam are available as power sources meeting the requirements. (auth)

974 PREPARATION OF MOLYBDENUM METAL POWDER BY THERMAL DECOMPOSITION OF HEXACARBONYL. Krichevskaya, O. D.; Bolotova, K. N.; Kremnev, V. L. (Research Inst. of Gipronickel, Leningrad). Porosh. Met., Akad. Nauk Ukr. SSR, No. 8, 17-20(Aug. 1969). (In Russian).

The effects of thermal decomposition of molybdenum hexacarbonyl on the bulk density of the obtained powder were studied. By varying the temperature and concentration of the molybdenum carbonyl powders with bulk density from 0.05 to 2.5 g/cm^3 and high dispersity were obtained. Powders with a bulk density of 2.5 g/cm^3 had a granulometric composition of 2 to 3 μm in size, in light powders (0.1 g/cm^3) it is less than 1 μm. (auth)

975 INVESTIGATION OF THE MECHANICAL PROPERTIES AND MICROSTRUCTURE OF TWO-PLY ROLLED NICKEL-MOLYBDENUM. Katrus, O. A.; Gribkov, V. K. (Inst. of Problems in Material Studies, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR, No. 8, 31-3(Aug. 1969). (In Russian).

Using powder metallurgy, a method was developed for the production of two-ply rolled nickel–molybdenum with increased indices of plasticity in comparison with pure molybdenum. (auth)

976 ACTIVATED SINTERING OF RHENIUM WITH PALLADIUM ADDITIVES. Dushina, O. V.; Nevskaya, L. V. Porosh. Met., Akad. Nauk Ukr. SSR, No. 8, 50-2(Aug. 1969). (In Russian).

The possibility is shown of applying activated sintering with introduction of palladium additive into rhenium powders. This additive is not harmful for the resulting articles. (auth)

977 METHOD FOR PREPARING TUNGSTEN POWDERS DOPED WITH REFRACTORY METAL OXIDES. Hansen, Robert D. (to The Dow Chemical Co.). U. S. Patent 3,475,159. Oct. 28, 1969. Filed Jan. 16, 1967.

Tungsten powders containing a controlled dispersion of a refractory metal oxide are prepared by (1) precipitating a novel, partially neutralized, particulate tungstic acid sol of the formula: $H_{2-a}(NH_4)_aWO_4 \cdot xH_2O$ where a is 0.1 to 0.3 and x is 0 to 2, prepared as ultrafine particles in a dendritic cluster form having a particle diameter of about 0.1 to 2 microns and containing sorbed refractory metal salts which decompose thermally to give refractory metal oxides, (2) separating the tungstic acid sol from the precipitation medium, (3) heating the sol to dryness at an elevated temperature in the presence of air to form the refractory metal oxide and a tungstic oxide, and (4) reducing the impregnated tungstic oxide to give a tungsten powder containing the refractory metal oxide. By control of the precipitation and impregnation process, sorption of the refractory metal salt can be obtained as either a surface coating of the particulate dendritic clusters or as an essentially uniformly distributed dispersion throughout each particle. (Offic. Gaz.)

978 PREPARATION OF HIGH-PURITY METALS AND SEMICONDUCTOR MATERIALS. Belyaev, A. I.; Zhemchuzhina, E. A.; Krapukhin, V. V.; Firsanova, L. A.; Chistyakov, Yu. D. Sb. Mosk. Inst. Stali Splavov, No. 52, 300-14(1968). (In Russian).

A review is given of purification of Al, In, Si, Ge, Te, Mg, Ti, B, W, Mo, Sb, and their compounds by zone melting, distillation in vacuum and under controlled atm, electron-beam melting, and H reduction; synthesis of several pure and doped intermetallic compounds; influence of impurities on semiconductor properties; synthesis of thermoelectric compounds; wetting of thermoelectric compounds by solders; and auto-, hetero-, and chemoepitaxy. (Selenium-Tellurium Abstr.)

979 SECONDARY VACUUM REFINING OF CADMIUM IN A CONTINUOUS-ACTION INSTALLATION. Esyutin, V. S.; Taziev, Zh. Sh.; Tseft, A. L. Tr. Inst. Met. Obogashch., Akad. Nauk Kaz. SSR, 26: 10-12(1967). (In Russian).

Studies were made on the possibility of recovering Cd from the primary distillation residue. The experiments were performed with a Cd alloy containing 0.51% Pb, 0.016% Cu, 0.007% Tl as well as other impurities (e.g., Sn and Ag) in amounts of <0.001% each. It was established that at 500°C and a residual pressure of 0.07 to 0.15 mm Hg redistillation of the distillation residue yields 99.99% pure Cd (extent of recovery: 74.33%). Analysis of the impurity-rich secondary distillation residue showed that it contains up to 3% Pb, 0.14% Cu, and 0.016% Tl; the amount of Cd recoverable from this secondary residue reaches 77%. The overall recovery of Cd from all three stages of distillation amounts to 98 to 98.5%, of which 88% of 99.999% purity, ~8% of the KD-O grade, and 2 to 2.5% of the KD-1 grade. The terminal residue, containing ≤6% Pb, ~0.3% Cu, and ~0.06% Tl, may be utilized for further recovery of the metals by the hydrometallurgical or pyrometallurgical method. (ATD)

980 BODY FOR THE SEPARATION AND PURIFICATION OF HYDROGEN AND ITS ISOTOPES. (to Varta A. G.). British Patent 1,168,457. Oct. 29, 1969. Priority date Dec. 16, 1965, Germany.

A pore-free shaped body is described for sorption of hydrogen. The body is formed by compacting a pulverized binder mixed with a pulverized hydrogen sorbing metal. The hydrogen sorbing metal is obtained by leaching out, with evolution of hydrogen, a catalytically inactive component from an alloy with the hydrogen sorbing metal and rendering this metal non-pyrophoric. (J.R.D.)

981 ELECTROWINNING OF HAFNIUM FROM HAFNIUM TETRACHLORIDE. Martinez, G. M. (Bureau of Mines, Boulder City, Nev.); Wong, M. M.; Couch, D. E. Trans. Met. Soc. AIME, 245: 2237-42(Oct. 1969).

The Bureau of Mines electrowon hafnium metal with an average oxygen content of 150 ppM at 700°C from an electrolyte containing 27 wt % LiCl, 62 wt % RbCl, and 11 wt % $HfCl_4$. The average anode and cathode current efficiencies were 90% at anode and initial cathode current densities of 86 A/ft^2. Hafnium metal with an average oxygen content of 440 ppM was electrowon at 800°C from an electrolyte containing 90 wt % KCl and 10 wt % $HfCl_4$. The average anode and cathode current efficiencies were similar to those obtained in the LiCl–RbCl–$HfCl_4$ electrolyte. The chlorine gas given off at the graphite anode was vented through either a silica or a graphite tube to prevent cell corrosion. (auth)

982 ADVANCES IN EXTRACTIVE METALLURGY. Proceedings of a Symposium Held in London from 17 to 20 April, 1967. London, Institution of Mining and Metallurgy, 1968. 1032p. (CONF-670458).

Separate abstracts were prepared for 4 of the 39 papers presented. (D.H.M.)

For abstracts of individual papers see: 295, 296, 983, and 984.

983 BERYLLIUM PREPARATION BY METALLIC REDUCTION OF BERYLLIUM CHLORIDE VAPOUR. Block, F. E.; Mussler, R. E.; Campbell, T. T. (Bureau of Mines, Albany, Oreg.). pp 551-71 of Advances in Extractive Metallurgy. London, Institution of Mining and Metallurgy, 1968.

From Symposium on Advances in Extractive Metallurgy, London, England. See CONF-670458.

Beryllium metal sponge was prepared by metallic reduction of beryllium chloride vapor in a manner similar to the Kroll process for producing reactive metals. Beryllium chloride was prepared by the direct chlorination of beryllium oxide and was purified by vacuum sublimation and also by scrubbing with a fused salt bath. Purified beryllium chloride vapor was reacted at a controlled rate with either lithium, sodium, or magnesium while under an inert atmosphere. Excess metal reductant and by-product salt were subsequently volatilized from the resulting beryllium sponge by heating in a vacuum. Cost analyses based on a plant to produce 100 tons of sponge per year were prepared for lithium and sodium reduction processes, both of which yield high metal recoveries. Costs for converting beryllium oxide to sponge were estimated at $9.80 and $7.33 per pound of beryllium for lithium and sodium reduction, respectively. (auth)(UK)

984 EXTRACTION OF NIOBIUM AND TANTALUM FROM THEIR ORES BY MOLTEN SALT ELECTROLYSIS. Bowles, P. J. (Warren Spring Lab., Stevenage, Eng.). pp 600-23 of Advances in Extractive Metallurgy. London, Institution of Mining and Metallurgy, 1968.

From Symposium on Advances in Extractive Metallurgy, London, England. See CONF-670458.

The application of fused salt electrolysis to the winning of metals from naturally occurring minerals is reviewed. Experimental work is described on the attempted reduction of pyrochlore, $(NaCa)Nb_2O_6F$, and the production of nickel–niobium alloys by the electrolysis of a solution of pyrochlore in barium fluoride at 1280°C, using a consumable nickel cathode. Electrolysis of a solution of columbite, $(Fe,Mn)(Nb,Ta)_2O_6$, in sodium fluoride at 1000°C produced an iron–niobium alloy and niobium carbide. (auth)(UK)

Properties Evaluations

Refer also to abstracts 206, 207, 375, 377, 395, 478, 966, and 1691.

985 (AGN-8191(Vol.7)) ALKALI METALS EVALUATION PROGRAM: THERMAL CONDUCTIVITY OF LIQUID SODIUM. Achener, P. Y.; Jouthas, J. T. (Aerojet-General Corp., San Ramon, Calif. Nuclear Div.). Aug. 1969. Contract AT(04-3)-368. 34p. Dep. CFSTI.

The thermal conductivity of liquid sodium was determined experimentally at temperatures from 280 to 1059°C. The comparative longitudinal flow method with concentric guard tube was used to generate the experimental data. The sample cavity and the reference bar were made of Ta-8% W-2% Hf alloy. The experimental data were correlated with the equation: $k_{Na} = 53.60 - 1.479 \times 10^{-2}\, t_{^\circ F}$ Btu $hr^{-1}\, ft^{-1}\, {}^\circ F^{-1}$ in engineering units, or: $k_{Na} = 0.2196 - 1.10 \times 10^{-4}\, t_{^\circ C}$ cal $sec^{-1}\, cm^{-1}\, {}^\circ C^{-1}$ in metric units. The standard error of estimate was evaluated at ±3.7%. (auth)

986 (GEAP-5714) NOTCHED HIGH-STRAIN FATIGUE BEHAVIOR OF THREE LOW-STRENGTH STRUCTURAL STEELS. Krempl, E. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Jan. 1969. Contract AT(04-3)-189. 41p. Dep. CFSTI.

The high-strain fatigue behavior of three notched low-strength structural steels (carbon steel, 2¼ Cr-1 Mo alloy steel, and Type 304 stainless steel), was investigated. Grooved cylinders with a uniaxial elastic stress concentration factors of $K_t = 3.3$ were tested at room temperature under completely reversed, load-controlled conditions. The axial and transverse cyclic strains were measured in the root of the notch, using 1/64-inch strain gages. Fatigue crack initiation and final failure were determined. Variations in the notch root strain range with cycling are significant above about 1.4 percent and reflect the cyclic strain-hardening characteristics of the steels. It was determined that fatigue strength reduction factors can be higher than K_t. Crack growth lives computed from striation density measurements compared reasonably well with observed crack growth lives of Type 304 stainless steel and carbon lives of Type 304 stainless steel and carbon steel. Separation of the specimens occurs when the true stress is around the true ultimate tensile strength of the steels. (auth)

987 (GEMP-702) NEW CORRELATION OF THE EFFECTS OF HOLD TIME ON LOW-CYCLE FATIGUE BEHAVIOR. Conway, J. B.; Berling, J. T.; Stentz, R. H. (General Electric Co., Cincinnati, Ohio. Nuclear Systems Programs). June 1969. Contract AT(40-1)-2847. 61p. Dep. CFSTI.

Closed-loop, servo-controlled, hydraulic testing machines were employed in axial strain control to measure the effect of hold time on the low-cycle fatigue behavior of fully annealed 304 and 316 stainless steel at 650°C in an air environment. The strain-wave forms studied include one involving equal hold periods at both peak tensile and peak compressive strains; another involving a hold period at peak tensile strain only; while the third was concerned with a hold period at the point of peak compressive strain. Tests were performed at constant strain rates (excluding the hold period itself) of 4×10^{-5} and 4×10^{-3} sec^{-1} over strain ranges to 2%. It was found that the hold period in tension only was particularly detrimental and led to drastic decreases in the cyclic fatigue life. Fatigue results obtained in the symmetrical-hold tests and in the compression-hold-only tests were found to be in good agreement with tests involving no hold periods when the fatigue behavior was compared on the basis of plastic strain range. (auth)

988 (GEMP-1012(Pt.2), pp 41-79) ADVANCED LONG-LIFE REACTOR FUEL CLADDING AND STRUCTURAL MATERIALS DEVELOPMENT. Robertshaw, F. C.; Bartos, J. L. (General Electric Co., Cincinnati, Ohio. Nuclear Systems Programs).

Work was begun to prepare a significant quantity of high-purity Type 316 stainless steel to establish base-line properties and radiation behavior, and plans made to study the effects of C, N, Mn, and Si on these characteristics. Three 135-kg heats were prepared and are being converted to sheet, rod, and tube blanks. Limited close-out activities were conducted on Cr-base, Fe-base (ferritic), and Fe–Cr–Al–Y compositions. In thermal stability studies, no change in hardness was observed in two of the primary Cr-base alloys (Cr–Hf–Th–Y and Cr–TZC–Y) in the warm-rolled condition after 2000 hours at 650°C. Exposure to a fluence of 2.3×10^{20} n/cm^2 ($E_n \geq 1$ MeV) at pile ambient temperature was found to increase significantly the ductile-to-brittle transition temperature in bending of the Cr–Y primary alloy but did not affect several of the Fe–Cr–Al–Y compositions. The best of the experimental Fe-base (ferritic) compositions was found to possess greater creep resistance than Type 316 stainless steel at temperatures up to about 575°C. (auth)

989 (GEMP-1012(Pt.2), pp 81-166) EVALUATION OF PLASTIC FATIGUE PROPERTIES OF HEAT-RESISTANT ALLOYS. Conway, J. B. (General Electric Co., Cincinnati, Ohio. Nuclear Systems Programs).

A special programmer was developed for use with the low-cycle fatigue machines to permit short-term tensile tests to be performed to 1000°C in air at constant values of true total axial strain rate. This represents the first reported capability of this type for use at these temperatures. A study was made to evaluate various test procedures to be used in biaxial fatigue measurements. Based on this study, a tentative decision has been made to employ either a flat cruciform-shaped specimen or a thin-walled tubular specimen to investigate the desired biaxial conditions. Analyses of the true stress–strain data for AISI Type 304, 316, and 348 stainless steel at temperatures to 816°C indicate good agreement with the Voce equation. Data are also presented to indicate the variation of the Voce equation constants with temperature. Relaxation data obtained in hold-time tests are shown to be in good agreement with relaxation data obtained in monotonic tensile relaxation tests at a strain equal to the strain amplitude of the hold-time tests. A study was made of the effects of the strain wave form and the length of the hold period at peak strain on the low-cycle fatigue characteristics of AISI 304 stainless steel at 650°C in air. Hold times in the tension portion of the cycle were found to be particularly detrimental and resulted in serious reductions in fatigue life. Hold times in both the tension and compression portions of a strain cycle and hold times in the compression cycle led to smaller reductions in fatigue life and these were correlatable with the increases in the values of the plastic strain range which resulted from the relaxation which occurs during the hold periods. Cyclic stress–strain characteristics for AISI Type 304, 316, and 348 stainless steel are compared to monotonic stress–strain results. A new correlation procedure was developed for use in predicting low-cycle fatigue data. A logarithmic plot of plastic strain range versus the cycles to failure divided by the cycling frequency yields a straight line having a slope of minus one. This line has been observed to pass through the tensile ductility point plotted at an abscissa value corresponding to the tensile ductility divided by the strain rate. (auth)

990 (GEMP-1012(Pt.2), pp 167-202) ADVANCE PRESSURE VESSEL MATERIALS. Robertshaw, F. C.; Stephan, H. R. (General Electric Co., Cincinnati, Ohio. Nuclear Systems Programs).

Activities in a program to determine the applicability of high-strength steels and alloys to nuclear reactor pressure vessels and similar critical applications are summarized. Plate materials under investigation include a 12 Ni–5 Cr–3 Mo maraging steel and a precipitation-hardening strainless steel, PH 13–8 Mo. The nickel-base high-temperature alloy, Inconel alloy 718, and a quenched and tempered alloy steel, HP 9 Ni–4 Co–.20 C, are also being investigated. All of the alloys being studied in this program can be processed to far greater tensile and yield strength levels than the alloys which are ASME Boiler and Pressure Vessel Code approved and in current use. Thus, their estimated design stress intensity values (S_m), based on data obtained in this program, are significantly higher than materials now used. The experimental approach being followed encompasses two phases. The first phase consists of selecting and procuring candidate materials in the form of approximately 2.54-cm-thick plate; then pertinent properties, response to heat treatment, weldability, and radiation resistance are evaluated. During the second phase heavier plate (≥10 cm thick) will be procured to determine size effects on properties, response to heat treatment, and weldability. Ultimately one or more alloys should emerge for high-strength pressure vessels. (J.R.D.)

991 (N-69-35547) DEEP DRAWING OF MOLYBDENUM AND ITS ALLOYS. Korolev, V. N.; (and others). Translated from Kuznechno-Shtampovochnoe Proizvod., 9: No. 10, 17-23(1967). 24p. (AD-687631; FTD-HT-23-1089-68). CFSTI.

The effect of various technological factors on the capacity for deep drawing of commercial-grade sintered molybdenum and TaM-2 and Vm-1 molybdenum alloys has been investigated on flat specimens, 6 mm wide and 0.5 and 0.8 mm thick, cut from rolled sheets in the direction alone, and/or transverse, or at a 45 deg angle to the direction of rolling. Test specimens in the annealed or strain-hardened condition were tested for mechanical properties under conditions of uniaxial and biaxial tension at temperatures of up to 500°C. Except for recrystallized sheet, the NDT temperature of all the investigated material was below room temperature. This showed that satisfactory parts can be produced from them by drawing at room temperature. The capacity for deep drawing depended mainly on the content of impurities, the microstructure and the deformation rate. Heating to 100-120°C significantly decreased the susceptibility to exfoliation and cracking and appreciably extended the technological use of the investigated metals. The capacity of sheet molybdenum for deep drawing increased with increasing prestraining at cold or warm rolling. The experimental results showed also the feasibility of progressive multi-operation deep drawing of thin wall parts from molybdenum and molybdenum-alloy sheets, with or without intermediate stress relieving. Depending on the sheet thickness, the direction of rolling and the heat treatment prior to drawing, the optimum temperature of drawing was within 220 to 350°C. (TAB)

992 (NIJS-P-245) MEASUREMENTS OF THE THERMAL CONDUCTIVITY AND ELECTRICAL RESISTIVITY OF HIGH-ALLOY FERRITIC STEELS. Perme, T.; Krstic, Dj.; Vodopivec, F. (Nuklearni Institut Jozef Stefan, Ljubljana (Yugoslavia)). June 1969. 31p. (In Slavic). Dep. CFSTI (U. S. Sales Only).

In work with materials for the fast breeder reactors, five high-alloy ferritic steels were chosen. The specimens were analyzed metallographically before and after the measurements. The thermal conductivities of these five specimens were measured by the radial heat flow method in the interval 70°C to 800°C. The accuracy of the measurements was ±8%. The electrical resistivities were measured by the UI method with ±2% accuracy from the room temperature to 800°C. The equipment, methods of measuring, and analysis of the accuracy of the measurements are described in detail. The measured temperature dependences are characteristic for high-alloy steels and increase with increasing temperature. At 800°C the thermal conductivities of five steels are between 0.24 to 0.27 W/cm°C. The electrical resistivities at 800°C are between 108 to 113 $\mu\Omega$ cm. (auth)

993 (UCRL-50004-67-1, pp 39-45) EXTRAPOLATED THERMODYNAMIC PROPERTIES OF SODIUM AND POTASSIUM. (California Univ., Livermore. Lawrence Radiation Lab.).

Methods of extrapolating known thermodynamic data on liquids used in Rankine cycles to temperatures and pressures above present limits were investigated. Research efforts devoted to equations of state, corresponding states, and quasi-chemical equilibrium methods of extending thermodynamic data are summarized. (J.R.D.)

994 EFFECT OF CHEMISTRY VARIATIONS ON THE STRUCTURAL STABILITY OF ALLOY 718. Rizzo, F. J.; Buzzanell, J. D. (Universal-Cyclops Specialty Steel Div., Bridgeville, Pa.). J. Metals, 22: No. 10, 24-33(Oct. 1969).

Because of the great interest in Alloy 718 by producers and users, the effects of variations in alloying elements on the microstructure and mechanical properties of Alloy 718 were studied. The procedure involved melting a series of experimental heats with wide variations in niobium, titanium, aluminum, and silicon. The effects of these various elements singularly and in combination on the structure and properties of this alloy were statistically determined. Studies were made on samples in two as-heat treated conditions and after exposure at 1200°F for an extended period of time. The microstructural characteristics of the various compositions have been evaluated by light and electron microscopy. Secondary phases present in these compositions have been identified by x-ray diffraction analysis of electrolytically extracted residues. An attempt has been made to correlate microstructure, mechanical properties, and chemistry for the experimental heats studied. (auth)

995 TRANSACTIONS OF THE INTERNATIONAL VACUUM METALLURGY CONFERENCE, BEVERLY HILLS, CALIFORNIA, JUNE 10-13, 1968. Barrow, R. B.; Simkovich, A. (eds.). New York, American Vacuum Society, 1968. 647p. (CONF-680623).

Thirty-seven papers are included; separate abstracts were prepared for 13. The remaining papers include information on: materials in vacuum environments; vacuum processing and testing equipment; vacuum deposition of bulk metal coatings; processing of materials in controlled environments, fabrication, joining, melting, and heat treating. (J.C.W.)

For abstracts of individual papers see: 951, 952, 968-973, and 996-1000.

996 EVALUATION OF THE HIGH-TEMPERATURE CREEP PROPERTIES OF REFRACTORY METAL ALLOYS IN VACUUM. Stephenson, R. L. (Oak Ridge National Lab., Tenn.). pp 15-27 of Transactions of the International Vacuum Metallurgy Conference. Barrow, R. B. (ed.). New York, American Vacuum Society, 1968.

From Vacuum Metallurgy Conference, Beverly Hills, Calif. See CONF-680623.

The high-temperature creep-rupture properties of various refractory metal alloys have been investigated in the temperature range from 1000 to 2200°C. Several alloys from each of the four refractory metal bases (Nb, Ta, Mo, W) have been evaluated for rupture times up to 1000 hr. The creep tests were performed in vacuum creep furnaces, employing cold-trapped oil-diffusion pumps, operating at pressures of less than 2×10^{-7} torr. The data are in reasonable agreement with those of other investigators who used ion-pumped apparatus. Although only single heats of material are represented, several conclusions seem evident. Niobium alloys, while quite fabricable, are the weakest of the four alloy bases. The more complex niobium alloys offer a significant improvement over Nb-1% Zr. The strength of early molybdenum alloys such as Mo-0.5% Ti drops sharply with increasing temperature; however, more complex alloys such as TZM and Nb-TZM are quite strong at moderate temperatures. Tantalum-base alloys combine good fabricability with useful strength over a broad range of temperatures. Tungsten and dilute tungsten-base alloys are the strongest at the highest temperatures. However, the addition of large amounts of lower melting point elements to tungsten lowers its creep strength. It was concluded that vacuum creep furnaces, operating in the pressure range from 10^{-7} to 10^{-8} torr, can yield useful data at a modest cost. (auth)

997 SUBLIMATION AND CONDENSATION OF HASTELLOY X IN NUCLEAR SPACE POWER SYSTEMS. Scannapieco, J. F.; Black, J.; Tweedie, A. T. (General Electric Co., Valley Forge, Pa.). pp 59-92 of Transactions of the International Vacuum Metallurgy Conference. Barrow, R. B. (ed.). New York, American Vacuum Society, 1968.

From Vacuum Metallurgy Conference, Beverly Hills, Calif. See CONF-680623.

An analytical study was made to develop a sublimation and condensation model which could determine the condensed film thickness as a function of time for any surface in a nuclear space power system. This was to be capable of being applied to any specific system design, including variations in materials and temperatures. An experimental study was made to investigate the sublimation and condensation characteristics of a typical high temperature superalloy, Hastelloy X. This included the parameters needed for the analytical study and other parameters which would give a basis for proposing a sublimation model of alloys. Parameters investigated include composition of the test environment, weight loss and rate, resistance of the condensed film, and composition of the condensate. (J.C.W.)

998 DESIGN, FABRICATION, AND OPERATION OF A HIGH TEMPERATURE, HIGH VACUUM BIAXIAL CREEP SYSTEM. Benn, E.; Fallandy, M. A.; Ferry, P. B. (Atomics International, Canoga Park, Calif.). pp 167-88 of Transactions of the International Vacuum Metallurgy Conference. Barrow, R. B. (ed.). New York, American Vacuum Society, 1968.

From Vacuum Metallurgy Conference, Beverly Hills, Calif. See CONF-680623.

The Large Radioisotope Heat Source Capsule Program is designed to develop the technology of isotope fuel capsules capable of operating in a space environment at a surface temperature of about 2000°F for up to five years. One phase of the program involves measurement of the creep of a T-111 (Ta-8W-2Hf) test capsule under variable biaxial stress, in a high vacuum, and at elevated temperature. The high vacuum test system designed to provide the necessary test environment and allow the required in-test creep measurements is described. The test system is designed to maintain a $1\frac{3}{4}$ in. dia. × 7 in. long T-111 capsule at 2000° ± 5°F, in a 10^{-8} torr vacuum for over 10,000 hours; to internally pressurize the capsule at a controlled rate during the test; and to provide in-test measurement of the capsule mid-diameter, at two angles, with a precision of ± 0.0001 in. The design criteria and final designs for each of the test system components are discussed in detail. Problems associated with construction and

checkout of the system are presented and a summary of system operation is given. (auth)

999 VACUUM TECHNOLOGY OF LIGHT ALLOYS. Greenewald, H. Jr. (North American Rockwell, Columbus, Ohio). pp 415-37 of Transactions of the International Vacuum Metallurgy Conference. Barrow, R. B. (ed.). New York, American Vacuum Society, 1968.

From Vacuum Metallurgy Conference, Beverly Hills, Calif. See CONF-680623.

The new technology which has been developed for using vacuum means for removing hydrogen from either liquid or solid light alloys without removing excessive amounts of volatile metallic constituents is reported. The use of these new methods has made practical the casting of ultrahigh strength aluminum alloy shapes which had not been possible heretofore, and a degree of reliability of mechanical properties in such cast high strength aluminum alloys which had not been attained before. The mechanisms involved in these achievements are discussed. The application of these techniques to the manufacture of high strength aluminum alloy matrix boron fiber composites is discussed. (J.C.W.)

1000 GAS EVOLUTION FROM REFRACTORIES DURING LADLE DEGASSING. Griffith, C. B.; Fedock, M. P. (Republic Steel Research, Cleveland). pp 463-78 of Transactions of the International Vacuum Metallurgy Conference. Barrow, R. B. (ed.). New York, American Vacuum Society, 1968.

From Vacuum Metallurgy Conference, Beverly Hills, Calif. See CONF-680623.

Information concerning the amount of gas evolved from ladle refractories and the behavior of various refractories during vacuum ladle degassing was needed for the design of suitable ladle degassing equipment. Eight types of commercial refractory bricks were evaluated as possible candidates for ladle refractories for the degassing process. The amount of gas evolved from heating these refractories under vacuum, the amount of gas evolved from the reaction of the refractories with the molten steel under vacuum, and observations concerning the physical behavior of the refractories under simulated ladle degassing conditions were measured. The experimental data were used to estimate the volume of gas that would be evolved if 50 tons of an unkilled 0.40% carbon steel was vacuum degassed for 15 minutes in a 130-ton ladle lined with each of the various refractories. The experimental data and physical properties were used to establish the relative rank of desirability of each of the refractories tested. The refractories with high alumina contents ranked highest with respect to the least amount of gas evolved, but ranked among the lowest with respect to the desirable physical properties. (auth)

1001 DIFFUSION OF NITROGEN IN TITANIUM AND ZIRCONIUM. Eremeev, V. S.; Ivanov, Yu. M.; Panov, A. S. Izv. Akad. Nauk SSSR, Metal., No. 4, 262-7(July-Aug. 1969). (In Russian).

A method of calculation of coefficients of diffusion in the formation of two phases and measurements of the parameters of diffusion of nitrogen in α and β phases of Ti and Zr at 1350 to 1700°C are proposed. (tr-auth)

1002 INTERACTION OF TANTALUM WITH HYDROGEN AT HIGH TEMPERATURES. Mazaev, A. A.; Avarbe, R. G. Izv. Akad. Nauk SSSR, Metal., No. 4, 268-9(July-Aug. 1969). (In Russian).

The interaction of Ta with H was studied at 1373 to 2973°K and pressures up to 100 atm. The proportional relationship between the solubility of hydrogen and the square root of the pressure was observed. Equations which describe the solubility of H in Ta at 1373 to 2973°K are given. (tr-auth)

1003 SOLUBILITY OF THE HYDROGEN IN MOLYBDENUM AT HIGH TEMPERATURES AND PRESSURES. Mazaev, A. A.; Avarbe, R. G.; Vil'k, Yu. N. Izv. Akad. Nauk SSSR, Metal., No. 4, 255-6(July-Aug. 1969). (In Russian).

The interaction of Mo with H was studied at 1373 to 2573°K at pressures of 1, 25, and 100 atm. The first approximation expresses the proportional relationship of the solubility of H to the square root of the pressure. Equations that describe the solubility of H in Mo at 1373 to 2573°K are included. (tr-auth)

1004 STABILITY AND PLASTIC PROPERTIES OF SOLID WC–Co DURING COMPRESSION. Tumanov, V. I.; Kreimer, G. S.; Safonova, O. S.; Chernyshev, V. V. Izv. Akad. Nauk SSSR, Metal., No. 4, 249-52(July-Aug. 1969). (In Russian).

The relationship of strength and the maximum of creep during compression of the alloy Co–WC (with 6 wt % and above Co) as a function of the Co content are described adequately by the theoretical equation: $\sigma_{Compr}\ (\sigma_s) = a/\sqrt{v} + b$, where V is the volumetric content of Co, and a and b are constants. The plastic deformation is directly proportional to Co content. The maximum of creep during compression and the hardness of the above alloys dependent upon the dimension of carbide grains are described by the following equation: $\sigma_s(H_v^{\infty}) = \alpha/d^{\frac{1}{2}} + \beta$. Three methods are used to show the stability and ductility of Co–WC alloys during compression at various temperatures during preparation of W and WC powders. (tr-auth)

1005 CONCERNING THE VISCOSITY OF LIQUID BERYLLIUM. Milov, I. V.; Klimov, Yu. F.; Skorov, D. M. Izv. Akad. Nauk SSSR, Metal., No. 4, 82-3(July-Aug. 1969). (In Russian).

The viscosity of liquid beryllium (99.85 to 99.9% pure) and its temperature dependence were determined by measurement of the thickness of the hydrodynamic layer (Prandtl layer) during turbulent motion of melted beryllium while being pumped through pipes at 1568 to 1673°K. It is postulated that the large grain structure of beryllium castings is determined in the melt of beryllium near its temperature of crystallization by the presence of quasi-crystalline regions of significant dimensions. (tr-auth)

1006 CREEP OF MULTICOMPONENT ALLOY OF NIOBIUM. Vasil'eva, E. V.; Prokoshkin, D. A.; Popov, N. N.; Lazarev, E. M. Izv. Akad. Nauk SSSR, Metal., No. 4, 187-90(July-Aug. 1969). (In Russian).

High-temperature creep at 1100 to 1320°C and stresses of 6 to 15 kg/mm^2 was studied in a niobium alloy which contains 10.85% W, 5.8% Ti, 2.0% Zr, and 0.08% C. The exponential dependence of the rate of creep on temperature and stress was determined. The strength of the alloy in the indicated temperature range was estimated and the stability characteristics were evaluated using parametric Larson–Miller functions. Temperature, stress, and time of disintegration of the alloy are tabulated. (tr-auth)

1007 THERMOELECTRIC PROPERTIES OF PALLADIUM–URANIUM ALLOYS. Vedernikov, M. V.; Terekhov, G. I.; Sinyakova, S. I.; Ivanov, O. S. Izv. Akad. Nauk SSSR, Metal., No. 4, 191-9(July-Aug. 1969). (In Russian).

An investigation of the temperature dependence of the electric properties of Pd–U alloys containing 0 to 17.5 at. % U at 20 to 1200°C confirmed the existence of the compound UPd_3, which is transformed above 800°C in disordered solid solution. The compound UPd_3 possesses the highest positive thermal emf among all known metallic materials, with sufficient ductility for the production of wires. Another property is high electric conductivity. The combination of these properties makes the material suitable for use in metallic thermocouples, which require high thermal emf at temperatures up to 700°C. (tr-auth)

1008 INVESTIGATION OF THE SOLUBILITY OF METALS IN RHENIUM AND CERTAIN PROPERTIES OF THE ALLOYS. Savitskii, E. M.; Tylkina, M. A.; Khamidov, O. Kh. Izv. Akad. Nauk SSSR, Metal., No. 4, 200-8(July-Aug. 1969). (In Russian).

The solubility of Ti, Zr, Hf, V, Nb, Ta, Mo, and W in solid Re was studied. Phase diagrams were constructed for the rhenium angle. Metals of groups III-A and IV-A exhibited the least solubility, those of group VIII showed the most. The effects of the transition metals of groups IV-A to VI on the crystalline, lattice, specific electrical resistance, hardness, strength, and ductility of rhenium were studied. The greatest changes in the properties of rhenium were induced by the metals of group IV-A. Hafnium and zirconium were the least soluble in solid rhenium among the alloying elements examined. The correlation between the magnitude of the deformation of crystalline lattice and the changes in physical properties of the rhenium alloys is noted. (tr-auth)

1009 EFFECT OF LANTHANUM ON THE SOLUBILITY OF THE CARBON IN MELTED IRON. Burylev, B. P.; Vasil'ev, V. V.; Rybalkin, E. M. Zh. Fiz. Khim., 43: 1907-9(July 1969). (In Russian).

The solubility of carbon in melted iron was studied upon addition of up to 20 wt % lanthanum at 1300 to 1700°C. The solubility isotherms were obtained for two minimums, which resulted in the formation of the C–La system and two carbides, LaC_2 and La_2C_3. The position of these minimums indicated the presence of Fe–La. (tr-auth)

1010 STABILITY OF WR 5/20 AND WR 10/20 TUNGSTEN–RHENIUM THERMOCOUPLES AT 1450 TO 2000°C. Oleinikova, L. D.; Oleinikov, P. P.; Trakhtenberg, L. I. Izmer. Tekh., No. 10, 31-2(Oct. 1969). (In Russian).

Stability of tungsten–rhenium thermocouples WR 5/20 and WR 10/20 was tested in the temperature range from 1450 to 2000°C in argon atmosphere. The thermocouples with thermoelectrodes of 0.1, 0.2, 0.35, and 0.5 mm were subjected to annealing for 20 hr. The results showed that the tests of thermo-

couples at 1450 and 1550°C do not change their calibration characteristics. The variations of thermal emf were correlated with metallographic analysis of thermoelectrode alloys. (tr-auth)

1011 MECHANICAL BEHAVIOR OF BERYLLIUM AT HIGH PRESSURE. Aladag, E. (Case Western Reserve Univ., Cleveland); Pugh, H. Ll. D.; Radcliffe, S. V. Acta Met., 17: 1467-81 (Dec. 1969).

The pressure dependence of the flow and fracture behavior of polycrystalline beryllium has been studied at room temperature and constant strain rate. Specimens were strained in tension under constant hydrostatic pressures up to 10 kilobars and the true stress and strain obtained from direct measurements of load and specimen cross section during the tests. The structural changes accompanying deformation and fracture were examined by both optical and transmission electron microscopy. Two types of well characterized beryllium — ingot and powder metallurgy — were studied in order to determine the influence of metallurgical variables. The yield behavior is found to be unaffected by pressure, whereas the fracture stress and strain increase with increasing pressure. At the higher pressures, plastic instability (necking) develops with 3-dimensional ductility and leads to area strains at fracture as high as 70%. Deformation mechanisms observed to operate, in addition to basal and prism slip, are non-basal slip and a new phenomenon, microkinking. An increase in strain hardening rate observed for the ingot Be under pressure is shown to be associated with the formation of observed sessile vacancy loops during plastic straining. The dominant fracture mode of the ingot Be is transgranular cleavage. For the pm Be, fracture is predominantly integranular up to 6 kilobars and then becomes transgranular with a corresponding increase in the pressure dependence of fracture stress. These differences are shown to be associated with the presence of oxide particles at the grain boundaries in the pm material. The measured pressure dependence of fracture stress compared with that predicted from current theory points to a possible effect of pressure and/or strain on the effective surface energy for crack propagation. The theory is not in good agreement with the observed incidence of micro-cracks and the pressure dependence of fracture at low pressures. The observations on pm Be indicate the need to incorporate the intergranular fracture mode in any general theory of the pressure dependence of fracture. (auth)

1012 INTERNAL NITRIDING OF TUNGSTEN-BASE ALLOYS CONTAINING HAFNIUM. Iden, D. J. (Materials Lab., Dayton, Ohio); Himmel, L. Acta Met., 17: 1483-99(Dec. 1969).

It is shown that W, W–Re, and W–Re–Mo alloys containing as much as 3 at. % Hf in solid solution are subject to internal nitriding when exposed to nitrogen gas at temperatures above about 1500°C. The hafnium nitride particles which are formed as a result of nitriding precipitate as plates on {001} matrix planes and this plate-like habit is retained up to at least 2000°C. At 1 atm N_2 pressure and temperatures between 1500 and 2000°C, the kinetics of internal nitriding are found to be controlled exclusively by the diffusion of nitrogen in the base metal or alloy matrix. The simple theoretical model developed by Wagner for the diffusion-controlled kinetics of internal oxidation is shown to provide an adequate description of the internal nitriding behavior. Permeation constants for nitrogen in W derived from the measured internal nitriding rates are found to be in good agreement with values obtained from direct steady-state permeation measurements. Using published solubility data, the diffusion coefficient for nitrogen in tungsten, $D = D_0 \exp(-Q_D/RT)$, has been evaluated from the relation $P = ND$, where P is the permeation constant and N the solubility at 1 atm pressure. The results yield $D_0 \cong 1.2 \times 10^{-2}$ cm²/sec and $Q_D \cong 32.2$ kcal/mole. (auth)

1013 ON THE LOW TEMPERATURE DEFORMATION MECHANISM IN POLYCRYSTALLINE CADMIUM. Sastry, D. H.; Prasad, Y. V. R. K.; Vasu, K. I. (Indian Inst. of Science, Bangalore). Acta Met., 17: 1453-7(Dec. 1969).

The thermally activated plastic flow of polycrystalline cadmium was investigated by differential-stress creep tests at 86°K and tensile tests in the temperature range 86 to 473°K. The activation energy (0.55 eV) at zero effective stress and the activation volume as a function of effective stress were obtained. It is concluded that intersection of glide and forest dislocations becomes rate controlling for low temperature deformation. The approximate stacking-fault width in cadmium is deduced to be 1.5b. (auth)

1014 HARDENING OF NICHROME WITH DISPERSED INCLUSIONS OF OXIDES. Antsiferov, V. N.; Polyakov, V. A. (Perm State Univ., USSR). Porosh. Met., Akad. Nauk Ukr. SSR, No. 8, 63-5(Aug. 1969). (In Russian).

The effects of dispersed inclusions of oxides (Al_2O_3, ZrO_2) on the properties of Nichrome were investigated. The alloys were prepared by powder metallurgy and 1, 2, 3, 4% by weight of Al_2O_3, or ZrO_2 were introduced into the Nichrome. It was shown that introduction of the dispersed inclusions of oxides resulted in an increase of the durability characteristics of the sintered Nichrome. Extrusion of the sintered samples increased the hardness and refractoriness. The alloy containing 3% by weight of ZrO_2 had the maximum strength at 900°C. (auth)

1015 EXCEPTIONAL MICROHARDNESS OF SUBGRAIN BOUNDARIES IN NIOBIUM SINGLE CRYSTALS. Raghuram, A. C. (Univ. of Maryland, College Park); Reed, R. E.; Armstrong, R. W. J. Appl. Phys., 40: 4666-8(Oct. 1969).

An investigation was conducted to determine whether a higher hardness occurs at subgrain boundaries in relatively pure Nb monocrystals. Electron-beam float zone-refined Nb monocrystals were prepared with two surfaces, (111) and 3° off (211), and microhardness measurements were made with a 1-g load. The results are plotted versus distance from sub-boundary; they show a hard region extending to 10 or 15 μm on either side of the sub-boundary. The magnitude of the excess hardness is small, about 20 or 25%. The effects of indentor direction, the asymmetry of the hardness profile, the scatter in the data, and the effects of varying load on hardness are discussed. (D.L.C.)

1016 NICKEL-BASE ALLOYS. Cape, Arthur T. (to Coast Metals, Inc.). U. S. Patent 3,475,165. Oct. 28, 1969. Filed Sept. 7, 1967.

The effects of cobalt additions to nickel-base alloys containing chromium, tungsten, iron and boron, and particularly the increase in Knoop hardness caused by such additions were determined. (Offic. Gaz.)

1017 MECHANICAL BEHAVIOR OF TANTALUM-BASE T-111 ALLOY AT ELEVATED TEMPERATURE. Sheffler, K. D.; Sawyer, J. C.; Steigerwald, E. A. (TRW Inc., Cleveland). ASM (Amer. Soc. Metals), Trans. Quart., 62: 749-58(Sept. 1969).

The tantalum-base alloy T-111 (Ta–8% W–2% Hf) has been creep tested in a vacuum environment of $<1 \times 10^{-8}$ torr at temperatures and stresses chosen to provide approximately 1% creep in times up to 15,000 hr. Design data from five different heats are presented in the form of a Larson Miller plot for 1% creep life. Elevated temperature tension test data show a strain aging reaction in the 1400 to 2200°F range which produces unusual transient creep behavior. Analysis of steady state creep data show that the minimum creep rate can be described by the expression: $\dot{\epsilon} = 1.65 \times 10^9 [\sinh (6.6 \times 10^{-5}\ \sigma)]^{3.17} e^{-90{,}000/RT}$ in the temperature and stress ranges of 1600 to 2600°F and 500 to 45,000 psi. These values of activation energy and stress exponent suggest that steady state creep of T-111 is governed by a diffusion controlled microcreep mechanism rather than by nonconservative dislocation motion. (auth)

1018 COEFFICIENTS OF THERMAL EXPANSION OF THE NIOBIUM–ZIRCONIUM–TITANIUM ALLOY AND ORGANIC GLASS BETWEEN 10 AND 300°K. Golik, V. R.; Petrenko, N. S.; Popov, V. P. (Physical-Technical Inst., Kharkov. Kharkov State Univ.). Ukr. Fiz. Zh., 14: 294-6(Feb. 1969). (In Russian).

Measurements were made on the coefficients of thermal expansion α of the niobium–zirconium–titanium alloy and organic glass used as materials for superconducting solenoids. The change in length was measured between 10 and 300°K by means of a dilatometer with an optical lever. The coefficient of expansion of the ternary alloy increased from $0.02 \cdot 10^{-5}$ at 20°K to $0.74 \cdot 10^{-5}$ at 275°K. The values of α for organic glass were 6 to 10 times as large as those for the alloy in this temperature range. (auth)

1019 DETERMINATION OF CREEPAGE MICRODEFORMATIONS, RESULTS OBTAINED ON A 52, 15 CD 2,05, AND Z6 CND 17-13 STEELS. Dollet, J.; Bastien, P. (Societe des Forges et Ateliers du Creusot, Le Creusot, France). Rev. Met. (Paris), 66: 361-74(May 1969). (In French).

New creep problems are posed by certain nuclear reactors, with their large dimensions and elevated working temperatures. Studies of deformation at temperatures between 400 and 600°C, with deformation less than 0.1%, were carried out on a C–Mn steel, a Cr–Mo steel, and an austenite Cr–Ni–Mo steel, at points corresponding to massive sheets and also construction joints. Apparatus with improved sensitivity, a microfluameter, was employed; results were obtained with sufficient approximation for practical application. The parameter of time and temperature equivalence is applicable as in classical creep, allowing extrapolation to long periods of time. In short tests one may determine the behavior of a given

steel for defined temperature and constraint conditions. High heat stability is hard to get above 450°C; austenite and Cr–M–V steels should be kept below this temperature. (BBB)

1020 PHYSICAL METALLURGY OF TITANIUM ALLOYS. Margolin, Harold; Farrar, Paul (New York Univ., N. Y.). Ocean. Eng., 1: 329-45(Feb. 1969).

A brief review of titanium physical metallurgy is given and related to alloy development work based on modification of the Ti–6Al–4V alloy. Highlights of the alloy development work are given. Observations are made on the manner in which Ti_3Al may contribute to seawater embrittlement and a possible direction for attaining yield strengths in the range 250 to 275,000 psi is indicated. (auth)

1021 ELLIPSOMETRY–LEED STUDY OF THE ADSORPTION OF OXYGEN ON (011) TUNGSTEN. Carroll, J. J.; Melmed, A. J. (National Bureau of Standards, Washington, D. C.). Surface Sci., 16: 251-64(Aug. 1969).

From Symposium on Recent Developments in Ellipsometry, Lincoln, Neb. See CONF-680840.

The direct combination of ellipsometry and low-energy-electron diffraction (LEED) techniques has been extended to a study of room temperature oxygen adsorption on (011) tungsten. It is shown that, by use of a special continuous data-taking method, ellipsometry is easily capable of detecting small fractions of a monolayer of adsorbed oxygen on this metal crystal face. From the partial correlation of LEED and ellipsometry data, average sticking probability for oxygen adsorption in the first ½ monolayer of atoms is deduced to be 0.2 or 0.4, depending on the choice of adsorption model. The experimental ellipsometry results are not understandable in detail in terms of existing ellipsometry theory. However, in view of the LEED results, it is felt that the results support a previously published adsorption model involving oxygen atom–tungsten atom rearrangements. (auth)

1022 RECYCLING OF PLUTONIUM FOR USE IN THERMAL REACTORS. Stoll, Wolfgang (Technische Geschaeftsfuehrer der Alkem, Hanau, Ger.). At. Strom, 15: 155-61(Sept. 1969). (In German).

The new commercial water-cooled reactors will lead to rapidly growing plutonium reserves before 1980 which will be more than can be used in fast breeders during this period. An alternative which includes recycling the plutonium for use in thermal reactors has been solved from the technical point of view. The extent to which one will make use of this recycling will depend on the price of the plutonium, the cost of fabricating the fuel for recycling, and on national reactor policies. (auth)

1023 THERMOELECTRIC PROPERTIES OF NIOBIUM–TANTALUM AND NIOBIUM–ZIRCONIUM ALLOYS. Druzhinina, I. P.; Fraktovnikova, A. A.; Vladimirskaya, T. M. Izmer. Tekh., No. 8, 36-8(Aug. 1969). (In Russian).

The thermoelectric properties of niobium alloys containing 5 to 97% Ta and 1 to 75% Zr were studied and compared with the thermoelectric properties of each pure metal. (auth)

1024 CURRENT STATUS OF TITANIUM–BORON COMPOSITES FOR GAS TURBINES. Metcalfe, A. G.; Schmitz, G. K. (International Harvester Co., San Diego, Calif.). J. Eng. Power, 91: 297-303(Oct. 1969).

A process to manufacture titanium–boron composites has been demonstrated with a 30-filament tape in which reaction is controlled to a few hundred angstroms of boride. This tape has good properties—indicating efficient use of the boron reinforcement—combined with good reproducibility (coefficient of variation of tensile properties approaches 2 percent). Simulated exposures confirm predictions that many thousands of hours of service life are possible at temperatures up to 1200°F. In addition, creep, fatigue, compression, cross tensile, and shear properties are presented. Application of this metal matrix tape to gas turbines is discussed. It is shown that the advantages of boron-reinforced plastic tapes in manufacturing are combined with the advantages of a metal matrix for shear load transfer, cross tensile strength, erosion resistance, and high-temperature performance. (auth)

1025 THERMODYNAMICS OF THE PLUTONIUM–BISMUTH SYSTEM. Lebedev, V. A.; Babikov, L. G.; Vavilov, S. K.; Nichkov, I. F.; Raspopin, S. P.; Skiba, O. V. At. Energ. (USSR), 27: 59-61 (July 1969). (In Russian).

Emf potentials of plutonium and its compounds in liquid bismuth solutions were studied to obtain thermodynamic data. The solubility of plutonium metal in bismuth was also determined. The emf potentials were measured at different temperatures and plutonium concentrations in the following cell: Pu(solid)|KCl – LiCl + wt % $PuCl_3$|Pu – Bi(liq). Plutonium activity coefficients in the bismuth solution are tabulated. A large negative deviation from Raoult's law is observed for the plutonium activity. An increase in temperature led to a noticeable increase in the activity coefficient which can be represented by the following equation: log(Pu Act. Coef.) = 1.490 – (8360/T), where T is in degrees Kelvin. The plutonium activity in saturated bismuth solutions is given by the following equations: 1) log A1 = 2.784 – (10,902/T) at 420 to 507°C, and 2) log A2 = 3.800 – (11,694/T) at 507 to 560°C. The solubility of Pu in liquid Bi is given by the following equations: 1) log Pu Soly = 1.022 – (2315/T) at 420 to 507°C, and 2) log Pu Soly = 2.038 – (3107/T) at 507 to 560°C. (TTT)

1026 DEFORMATION OF NEODYMIUM AS A FUNCTION OF TEMPERATURE AND RATE OF DEFORMATION. Skudnov, V. A.; Sokolov, L. D.; Gladkikh, A. N. Vestsi Akad. Navuk BSSR, Ser. Fiz.-Tekh. Navuk, No. 2, 114-16(1969). (In Russian).

Specimens of 99.16% pure neodymium for mechanical testing were obtained by pressing at 923°K and annealing in a vacuum of 10^{-4} mm Hg at a temperature of 0.5 $T_{melting}$. The results of mechanical tests performed at temperatures from -196°C to 800°C in argon atmosphere and at strain rates of 0.02 and 0.20 cm/sec are presented. The ductility and strength peaks were observed to decrease at temperatures equal to 0.2 and 0.4 times the melting point temperature, and to increase at 0.5 times the melting point temperature. At higher temperatures these effects were reduced, and higher temperatures and increased strain rates increased the ductility. (tr-auth)

1027 CALCULATION OF THE THERMODYNAMIC AND TRANSPORT PROPERTIES OF SODIUM, POTASSIUM, RUBIDIUM, AND CESIUM VAPORS TO 3000°K. Lee, C. S.; Lee, D. I.; Bonilla, C. F. (Columbia Univ., New York). Nucl. Eng. Design, 10: 83-114(May 1969).

The vapor pressure, composition, compressibility factor, specific heat, specific heat ratio, density, sonic velocity, viscosity, thermal conductivity and Prandtl number of sodium, potassium, rubidium and cesium vapors under saturated and superheated conditions, and for frozen or variable equilibrium compositions, were calculated by kinetic theory up to 3000°K. These properties are of use in the design of nuclear liquid metal coolant and power systems. (auth)

1028 ON THE POSSIBLE INFLUENCE OF STACKING FAULT ENERGY ON THE CREEP OF PURE BCC METALS. Vandervoort, R. R. (Univ. of California, Livermore). Trans. Met. Soc. AIME, 245: 2269-72(Oct. 1969).

The creep behavior of Nb, Ta, Mo, and W was determined under conditions of constant atomic diffusivity, constant stress to elastic modulus ratio, and nearly equivalent grain size, and the steady-state creep rates obtained from these tests were correlated with calculated stacking fault energies for the metals. These results, in conjunction with similar data for several fcc metals, suggest that stacking fault energy may influence the creep strength of bcc metals. The interrelationship between steady-state creep rate, subgrain size, and stacking fault energy was examined. It was found that the subgrain size for a given creep stress, increased as stacking fault energy increased, but that this relationship did not completely account for the effect of stacking fault energy on creep rate. (auth)

1029 STRUCTURAL MATERIALS AND WELDING FOR STEAM GENERATORS IN SODIUM-COOLED FAST BREEDER REACTORS. Mochizuki, Hiroji (Kawasaki Dockyard Co., Kobe, Japan). FAPIG (Tokyo), No. 53, 52-61(May 1969). (In Japanese).

To ensure safety, great care is required in the selection of materials and the design and construction of steam generators for sodium-cooled fast breeder reactors, because of the sodium atmosphere and the reaction between sodium and water. In this connection, experimental studies have been carried out on Cr–Mo steel and austenitic stainless steels. Welding of these steels was also studied to establish the technology of design and construction of steam generators. These studies and the results of experiments so far obtained are described, with emphasis on rupture tests, tube welding, and thermal shock testing of materials. In this program, a variety of rupture tests were made to establish the proper conditions of welding, and also thermal shock and thermal fatigue properties of the base metals and the welds. (NSA of Japan)

1030 THE APPLICATION OF THORIA YTTRIA ELECTROLYTES IN MEASURING THE THERMODYNAMIC PROPERTIES OF CHROMIUM IN ALLOYS. Lidster, P. C. (Univ. of Newcastle-upon-Tyne, Eng.); Bell, H. B. Trans. Met. Soc. AIME, 245: 2273-7(Oct. 1969).

A study was made of the use of $ThO_2 – Y_2O_3$ solid electrolytes

to determine activity of chromium in Fe–Cr and Ni–Cr alloys in the temperature range 1300 to 1700°K. This method gave results which agreed with the best vapor pressure measurements. (auth)

1031 CERTAIN PROPERTIES OF GERMANIDES OF PRASEODYMIUM. Rud, B. M.; Lynchak, K. A.; Paderno, Yu. B. (Inst. of Problems of Science of Materials, Moscow). Izv. Akad. Nauk SSSR, Neorg. Mater., 5: 1350-3(Aug. 1969). (In Russian).

The temperature relationship of specific resistance and thermal-emf, the Hall effect at room temperature, the coefficient of thermal expansion, and the melting points and microhardness of Pr_5Ge_3, PrGe, and $PrGe_2$ were measured. Conductivity changes in conductors to semiconductors during phase transformations were found. The compounds possess high conductivity and low mobility. Melting points and microhardness values increase from $Pr_5Ge_3 \rightarrow PrGe \rightarrow PrGe_2$. Chemical stability increases with germanium content in the compound. (tr-auth)

Structure and Phase Studies

Refer also to abstracts 175, 952, 1008, and 1309.

1032 (ANL-Trans-782) STUDY OF INTERNAL FRICTION OF ALLOYED MOLYBDENUM. Busalov, Yu. E.; Kopetskii, C. V.; Kop'ev, I. M.; Smolyakova, L. G. Translated for Argonne National Lab., Ill., from Fiz. Khim,. Obrab. Mater., No. 1, 117-18(1968). 6p. Dep. CFSTI.

An investigation was conducted to determine the degree of dislocation freezing during microalloying of Mo with elements of group VII-A. Resulting data are the basis for a conclusion that a reduction of the energy of dislocation reaction with solute impurities occurs in microalloyed Mo. (J.R.D.)

1033 (GEMP-707) IDENTIFICATION OF YTTRIUM-IRON INTERMETALLIC PARTICLES IN Fe–Cr–Al–Y ALLOYS. Bartos, J. L. (General Electric Co., Cincinnati, Ohio. Nuclear Systems Programs). June 27, 1969. Contract AT(40-1)-2847. 12p. Dep. CFSTI.

Two Fe–Cr–Al–Y alloys were examined with the electron microprobe in order to determine the chemical composition of the intermetallic particles and alloy matrices. The results reveal that particles to be mixtures of two yttrium–iron compounds, YFe_5 and Y_2Fe_{17}. A small amount of chromium and aluminum are present in solid solution. The presence of chromium appears to promote formation of Y_2Fe_{17} over YFe_5. The composition of the matrices and particles was not affected by annealing the extruded samples or aging the annealed specimens. (auth)

1034 (Y-1694) A STUDY OF THE TIME-TEMPERATURE TRANSFORMATION BEHAVIOR OF A URANIUM–7.5 WEIGHT PER CENT NIOBIUM–2.5 WEIGHT PER CENT ZIRCONIUM ALLOY. Dean, C. W. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Oct. 24, 1969. Contract W-7405-eng-26. 101p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

The time-temperature transformation behavior of the γ phase of a uranium-7.5 weight per cent niobium-2.5 weight per cent zirconium alloy was determined for the temperature range from 200 to 800°C. Metallography, microhardness, and x-ray diffraction techniques were used to determine a time-temperature transformation diagram. The diagram was found to consist of two overlapping C curves. The morphology of the transformation was: a lamellar structure above the upper nose, a fine precipitation of α-uranium platelets below this nose, and a Widmanstatten pattern which has its time-temperature relationship defined by the lower nose. The critical temperature was determined to be 650°C. Above this temperature the body-centered cubic γ phase was stable. Upon water quenching to room temperature, a transition phase, γ^1, was formed in which the body-centered atoms are slightly shifted. Upon aging, this phase transformed to γ^0, which is tetragonal. Further aging produced α^2 which has a monoclinic crystal structure and is observed metallographically as a Widmanstatten pattern. The hardness of the α^2 phase varied from 250 to over 600 dph when the material was completely transformed. Aging samples in water-saturated gases were found to significantly retard the beginning of the γ-phase decomposition. Under certain conditions, a substructure was found to be visible. (auth)

1035 PHASE DIAGRAMS OF THE Mo–Hf–C SYSTEM IN THE Mo-RICH REGION. Zakharov, A. M.; Savitskii, E. M. Izv. Akad. Nauk SSSR, Metal., No. 4, 223-30(July-Aug. 1969). (In Russian).

Microscopic and x-ray phase and structural analyses were made and the temperature of initial melting and microhardness were studied from the Mo region of the system Mo–Hf–C with 0 to 0.6 wt % C and 0 to 10% Hf. Isotherms of the solidus surface and isothermal cross sections were constructed at 2100 and 1250°C and the polythermal section of Mo–HfC. At 2100 and 1250°C γ-Mo_2C and β-HfC were in equilibrium with the Mo α-solid solution. It was confirmed that the Mo–HfC cross section in the Mo–Hf–C system has quasi-binary characteristics and a diagram of the eutectic type. The eutectic of $\alpha + \beta$-HfC is melted at 2350 ± 20°C. The solubility of β-HfC in solid Mo varies, decreasing when the temperature is lowered. The maximum solubility of β-HfC in Mo at 2350°C is approximately 3.3 wt %; at 2100°C, 0.9 wt %; and at 1250°C, 0.5 wt %. (tr-auth)

1036 PHASE DIAGRAMS OF THE Ti–Ta–Cr SYSTEM. Gavze, A. L.; Budberg, P. B.; Minaeva, S. A. Izv. Akad. Nauk SSSR, Metal., No. 4, 241-5(July-Aug. 1969). (In Russian).

A diagram of fusibility was constructed for a section of the Cr–Ta–Ti system at the Ta–Ti side and at the section passing through the compounds $TaCr_2$–$TiCr_2$. Isothermal cross sections of the investigated system at 1200, 1000, and 800°C were studied using microstructural, x-ray analysis, and hardness measurements. (tr-auth)

1037 INVESTIGATION OF THE Hf–Fe–Al SYSTEM IN THE REGION UP TO 33.3 AT. PERCENT Hf. Burnashova, V. V.; Ryabov, V. R.; Markiv, V. Ya. (Lvov State Univ.). Dopov. Akad. Nauk Ukr. RSR, Ser. A, No. 8, 741-3(Sept. 1969). (In Ukrainian).

The Hf–Fe–Al system (the region up to 33.3 at. % Hf) was investigated by means of x-ray and microscopic analyses. The phase equilibria were determined and the existence of two ternary compounds (Ψ and X) was established. Ψ-phase had a narrow homogeneity range extending by 7.7 at. % Hf from ~37 to 61 at. % Al. Its structure belonged to the $ThMn_{12}$-type (a = 8.50 – 8.65 Å, c = 4.92 Å). The x-phase contains 14 at. % Hf, 20 at. % Fe, and 66 at. % Al. Its structure has not been determined. (auth)

1038 PHASE DIAGRAM OF THE SYSTEM CHROMIUM–PRASEODYMIUM. Svechnikov, V. M.; Kobzenko, G. F.; Kashevskaya, O. M.; Ivanchenko, V. G.; Martinchuk, E. L. (Inst. of Metal Physics, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. A, No. 8, 748-51(Sept. 1969). (In Ukrainian).

By means of differential thermal, metallographic, and x-ray crystal analyses the chromium–praseodymium alloys were investigated in the whole range of concentrations and the phase diagram was plotted for the first time. The presence of an allotropic transformation in praseodymium at a temperature of 790° was substantiated, and another at a temperature of 875°C established. (auth)

1039 ELECTROCHEMICAL EFFECT IN ALLOYS OF CADMIUM, MAGNESIUM, AND MERCURY. Inglesfield, J. E. (Cambridge Univ., Eng.). Acta Met., 17: 1395-1402(Dec. 1969).

The alloying behavior of simple metals can be discussed in terms of a single electronic potential, the alloying potential, in a pseudopotential formalism. In these terms the alloying behavior of the Cd–Hg, Cd–Mg, and Hg–Mg systems is studied using a square well potential whose depth A is proportional to the electronegativity difference. The tendency for intermediate compounds to be ordered in systems with a large electronegativity difference is explained because ordering energies are proportional to A^2. To explain the tendency to have many intermediate phases of narrow width of homogeneity as the electronegativity difference increases, a large value of A is not sufficient and changes in structure must be considered. A large A favors the appearance of intermediate compounds with ionic structures, and these structures are associated with a narrow width of homogeneity. (auth)

1040 INFLUENCE OF TUNGSTEN ON THE γ' TO η TRANSFORMATION AND CARBIDE REACTIONS IN NICKEL-BASE SUPERALLOYS. Havalda, Andrej (Inst. of Metal Physics, Bratislava). ASM (Amer. Soc. Metals), Trans. Quart., 62: 581-9(Sept. 1969).

The influence of tungsten on phase reactions which occur in the solid state to attain equilibrium at 850°C was studied for Ni–Cr–Ti–Al alloys with various combinations of Al + Ti and approximately 0.15 wt % carbon. The material was studied in the as-cast condition after a homogenization treatment of 150 hr at 1,200°C,

and aging at 850°C for up to 1,000 hr. Two important reactions were influenced by tungsten in these alloys, the breakdown of metastable γ'-(Ni_3Ti) to the stable η-(Ni_3Ti), and the change from metastable to stable carbides. An increased tungsten content retarded the reaction of the metastable γ' phase to stable η. The $\gamma' \rightarrow \eta$ reaction was found to take place by continuous as well as by discontinuous precipitation of η. Tungsten in alloys with a high titanium content suppressed the formation of the carbide M_7C_3; and in high aluminum alloys, either suppressed, M_7C_3, or increased the reaction $M_7C_3 \rightarrow M_{27}C_6$, or both. (auth)

1041 PRECIPITATION IN NICKEL-BASE ALLOY 718. Paulonis, D. F.; Oblak, J. M.; Duvall, D. S. (Pratt and Whitney Aircraft, Middletown, Conn.). ASM (Amer. Soc. Metals), Trans. Quart., 62: 611-22(Sept. 1969).

The nickel-base superalloy Alloy 718 has several unique strength characteristics but conflicting reports exist as to the nature of the strengthening precipitate in this material. A comprehensive study of the principal precipitates in Alloy 718 was therefore conducted using dark field electron microscopy and electron and x-ray diffraction. It was shown that the major strengthening phase in this alloy was a disc-shaped body centered tetragonal (DO_{22}) precipitate rather than the fcc ($L1_2$) γ' found in most nickel-base superalloys. The latter phase was detected, but in smaller quantities. On exposure to moderately high temperature (1,200 to 1,550°F), both precipitate phases coarsen but the bct phase is still predominant. After 16 hr at 1,600°F the γ' is taken into solution while the remaining bct phase further coarsens. It appears that the deterioration of properties above ~1,200°F results from coarsening and partial solution of the two ordered phases. Fully heat treated samples deformed at both room temperature and elevated temperatures exhibited planar deformation banding, a slip mode characteristic of nickel-base superalloys. (auth)

1042 AN ANALYSIS OF CREEP-INDUCED INTRINSIC/EXTRINSIC FAULT PAIRS IN A PRECIPITATION HARDENED NICKEL-BASE ALLOY. Kear, B. H.; Leverant, G. R.; Oblak, J. M. (Pratt and Whitney Aircraft, Middletown, Conn.). ASM (Amer. Soc. Metals), Trans. Quart., 62: 639-50(Sept. 1969).

Intrinsic/extrinsic stacking fault pairs were observed during creep of single crystals of a γ'-precipitation hardened nickel-base alloy. An extensive analysis of the dislocations bounding these faults has revealed the presence of both a/6 ⟨112⟩ and a/3 ⟨112⟩ partials, with the net Burgers vector for the intrinsic/extrinsic pair a ⟨112⟩. A viscous slip model is developed to explain the motion of these intrinsic/extrinsic fault structures through the two phase material. (auth)

1043 EFFECT OF ELASTIC CONSTRAINTS ON ELECTRON ENERGY LOSS MEASUREMENTS IN INHOMOGENEOUS ALLOYS. Cook, R. F.; Howie, A. (Cavendish Lab., Cambridge, Eng.). Phil. Mag., 20: 641-6(Sept. 1969).

Inhomogeneous alloys are subject to elastic constraints which should be considered when segregation studies are made by means of electron energy loss measurements. The correction to the recent grain boundary segregation measurements of Cundy, Metherell, Whelan, Unwin and Nicholson (1968) is small, but indicates that greater segregation occurred than had been supposed. (auth) (UK)

1044 MEAN SQUARE AMPLITUDE OF THERMAL VIBRATIONS IN CUBIC METALS AT MELTING POINT. Sharma, P. K.; Singh, Narain (Univ. of Allahabad, India). Chem. Phys. Lett., 4: 1-2(Sept. 15, 1969).

The ratio of the mean square amplitude of thermal vibrations and the square of the interionic separation at the melting temperature has been determined for a number of cubic metals using the Chéveau model for the phonon spectrum. It is found that the ratio varies with the metal inversely as the cube root of the atomic mass. (auth)

1045 MECHANISM OF SECONDARY RECRYSTALLIZATION IN MOLYBDENUM FOIL. Dubovitskaya, N. V.; Larikov, L. N. Fiz. Metal. Metalloved., 27: 710-15(Apr. 1969). (In Russian).

Molybdenum foil obtained by deformed rolling and which contained approximately 0.5% Ti and 0.05% C was used with diffractive electron microscopy for studying the mechanism of secondary recrystallization. During annealing, which led to the initial recrystallization, there occurred the separation of dispersed particles of the second phases which are complex molybdenum carbide of Type M23C6. Secondary recrystallization occurred at higher temperatures of 1500 to 1950°C. The formation and growth of the normal grains were accompanied by the appearance of voids between grain boundaries. Annealing at temperatures above 2000°C led to the dissolving of the carbide particles and resulted in scattering of the primary recrystallization. (tr-auth)

1046 THE INFLUENCE OF MISFIT ON THE MORPHOLOGY AND STABILITY OF THE OMEGA PHASE IN TITANIUM–TRANSITION METAL ALLOYS. Williams, J. C. (North American Rockwell Science Center, Thousand Oaks, Calif.); Blackburn, M. J. Trans. Met. Soc. AIME, 245: 2352-5(Oct. 1969).

The morphology of the ω phase in several titanium–transition metal alloys was determined by transmission electron microscopy. The phase was cubical in Mn–Ti, Fe–Ti, and Cr–Ti alloys. The morphology of the ω phase was controlled by the misfit between the precipitate and matrix lattices; the phase having an ellipsoidal morphology in low misfit systems (<1%) and a cubical morphology in high misfit systems (>1%). In alloy systems with a large misfit the α phase forms at misfit dislocations in the $\beta:\omega$ interface. In lower misfit alloys the separate nucleation and growth of the α phase becomes kinetically more favorable. (G.M.C.)

Radiation Effects

Refer also to abstracts 406, 491, 988, 990, 1478, and 2040.

1047 (BMI–1868, Sect.B) RADIATION EFFECTS ON FAST-REACTOR CLADDING AND STRUCTURAL MATERIALS. (Battelle Memorial Inst., Columbus, Ohio). 26p.

Research and development progress is reported on mechanical properties of cladding materials, methods of determining radiation effects on cladding materials, effects of fast fluxes on mechanical properties of cladding, and elevated temperature radioinduced embrittlement of cladding. (J.R.D.)

1048 (CEA-CONF–1293) EFFECT OF IRRADIATION ON THE OXIDATION AND THE HYDROGENATION OF ALLOYS OF ZIRCONIUM IN WATER AT HIGH TEMPERATURE. Blanchet, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [1968]. 26p. (In French). (CONF-681218–1). Dep. CFSTI (U. S. Sales Only).

From Conference on Nuclear Corrosion, Paris, France.

A bibliographic review was made of the corrosion of zirconium alloys in high-temperature water and superheated steam. The majority of the previous studies agreed that β and γ radiation had no effect on the corrosion of zirconium alloys but that fast neutrons increased under certain conditions, the corrosion kinetics of zirconium alloys in water at high temperature. The importance of this effect seems connected with the intensity of the fast neutron flux, the oxygen content, and the temperature. It is doubtful that a zirconium alloy can be practically used in water vapor above 450°C. (J.S.R.)

1049 (GEAP–10079) ZIRCALOY-CLAD UO_2 FUEL ROD EVALUATION PROGRAM. Quarterly Progress Report Nos. 6 and 7, February–July 1969. Megerth, F. H. (comp.) (General Electric Co., San Jose, Calif. Reactor Fuels and Reprocessing Dept.). Aug. 1969. Contract AT(04-3)-189. 20p. Dep. CFSTI.

Longitudinal tensile coupon specimens obtained from the cladding of several fuel rods were tested at room temperature, 343, 399, and 454°C. The integrated fast neutron exposure of this material was estimated to be 3×10^{21} to 4×10^{21} nvt >1 MeV. The high temperature ultimate strengths ranged from about 5000 kg/cm^2 at 343°C to about 3000 kg/cm^2 at 454°C. These values represent a total radiation-induced strength increase of approximately 1000 to 2500 kg/cm^2. Increases in yield strength were comparatively greater; the differences between ultimate strength and yield strength in the irradiated material were generally ≤70 kg/cm^2 in the high temperature tests. The total and average uniform elongations of the unirradiated archive material were measured at 343 to 454°C. The average 343°C ultimate strength of the present irradiated specimens was about 700 kg/cm^2 greater than the 343°C ultimate strength of comparable specimens irradiated in the VBWR to ~1×10^{21} nvt >1 MeV, and the total elongation was ~0.3% lower. There were no distinct differences in the ultimate-yield strength differential or in the uniform elongation. Similarly, microhardness measurements on current SA-1 cladding specimens indicated some increase in hardness when compared with specimens from Fuel Cycle Program fuel rods whose exposure was limited to VBWR operation. Samples of SA-1 fuel rod cladding that had been exposed to a fast neutron fluence of approximately 4×10^{21} nvt >1 MeV were examined by transmission with a 100 keV electron microscope. So far, no evidence of radioinduced voids has been observed. The radial dependence of burnup, uranium, and plutonium isotopic contents, and the atom ratios of ^{238}U relative to ^{239}Pu, ^{238}Pu, ^{241}Am, ^{242}Cm, ^{244}Cm, ^{144}Nd, ^{137}Cs, ^{134}Cs, ^{106}Ru, and ^{144}Ce was determined from analyses of fuel samples taken at different radial locations from one of the relatively low exposure fuel rods. The ^{236}Pu contents were measured on full cross section fuel samples from four rods. The atom ratios of ^{236}Pu to ^{238}U

ranged from about 3×10^{-10} to 5×10^{-10}. The fuel sample burnups were between 7×10^{20} and 8×10^{20} fissions/cc. (auth)

1050 (NRL–6945) BEHAVIOR OF MECHANICAL PROPERTIES IN NEUTRON-IRRADIATED 12Ni–5Cr–3Mo MARAGING STEEL PLATE AND COMPANION WELD METALS. Gray, R. A. Jr.; Hawthorne, J. R. (Naval Research Lab., Washington, D. C.). June 6, 1969. Contract AT(49-5)-2110. 20p.

Changes of Charpy V notch-ductility and tensile strength in neutron-irradiated 12Ni-5Cr-3Mo maraging steel have been evaluated following low (<250°F) and elevated (550 to 740°F) temperature exposure. The study was performed with six heats of 1-in.-thick plate material aged at 900°F for 2 and 20 hr to nominal yield strengths of 160 and 180 ksi, respectively. The long-term thermal stability of both heat-treatment conditions was investigated for the conditions of irradiation. The <250 and 550°F irradiation performance of matching (12-5-3) and mismatching (17Ni-2Co-3Mo) TIG weld deposits maraged to 180 ksi yield strength was also assessed in this study. Changes in the general properties of the 12-5-3 maraging steel plate and companion weld metals was found to be rather small with <250°F exposures, indicating good resistance to neutron-induced embrittlement. However, a marked deterioration of notch-ductility properties with long-term exposure at elevated temperature was revealed and traced to a nonnuclear thermal instability. The observed instability is believed to be a continuation of aging processes at temperatures well below the initial maraging temperature. Extended time-at-temperature treatments indicate that service above 550°F may produce sufficient changes in properties for failure by low-energy tear. Aging treatments of 1900 to 3300 hours' duration increased the yield and tensile strengths of the 12-5-3 alloy by as much as 52.0 and 53.3 ksi, respectively, while not altering appreciably the percentage of elongation and the reduction in area. (auth)

1051 (ORO–3612-6) AN INVESTIGATION OF IRRADIATION STRENGTHENING OF B.C.C. METALS AND SOLID SOLUTIONS. Progress Report, January 1969–October 1969. (Maryland Univ., College Park). Contract AT(40-1)-3612. 72p. Dep. CFSTI.

Investigations of changes in metal dislocation dynamics caused by neutron irradiation are reported. Information is included on the effects of neutron irradiation and oxygen interstitials on dislocations in V and on strain dependence of the activation volume in irradiated V. Other work is reported on methods of producing high-purity V. Discussions are included on relations between dislocation velocity and macroscopic deformation in bcc metals and on radiation strengthening of copper single crystals. (J.R.D.)

1052 IN-REACTOR OXIDATION OF ZIRCONIUM ALLOYS IN pH 10 LiOH AND pH 10 NH_4OH. Johnson, A. B. Jr. (Battelle-Northwest, Richland, Wash.). pp 49-58 of High Purity Water Corrosion of Metals. Houston, Tex., National Association of Corrosion Engineers, 1968.

From 23rd Annual Meeting of the National Association of Corrosion Engineers, Los Angeles, Calif. See CONF-670312.

Results of in-flux corrosion studies in the G-7 loop of the Engineering Test Reactor are summarized. Corrosion data were obtained from tensile specimens and from coupons of two sizes. Six zirconium alloys were exposed in various combinations in three G-7 loop environments: pH 10 LiOH, ~1 ppM O_2; pH 10 LiOH, ~0.1 ppM O_2; and pH 10 NH_4OH, <0.05 ppM O_2 at 270 to 280°C. Alloys exposed in the lithiated environments consistently underwent pronounced flux-induced oxidation. In the ammoniated environment, flux-induced oxidation was small or absent on specimens exposed as-etched. However, three of six alloys exposed after prefilming at 400°C in 1500 psi steam underwent considerable flux-induced oxidation. Specimens, prefilmed at 300°C also showed accelerated oxidation, but not to the degree observed on specimens prefilmed at 400°C. Specimens exposed at G-7 loop out-of-flux positions ~1 sec and ~1 min from the flux did not differ significantly in oxidation rate or hydrogen pickup. Hydrogen pickup was not significantly accelerated by flux unless the oxidation rate was affected. Exposures in the irradiated ammoniated coolant also showed little effect of the hydrogen in the coolant on hydrogen pickup after 77 days. Results from the G-7 loop exposures and from zirconium alloy corrosion in other reactors are consistent with the view that accelerated oxidation is dependent on the dissolved oxygen level in the coolant. (auth)

1053 AMMONIA REDUCES OXYGEN ATTACK ON Zr ALLOYS UNDER REACTOR RADIATION. Lesurf, J. E.; Bryant, P. E. C. (Atomic Energy of Canada, Ltd., Chalk River, Ont.). pp 42-8 of High Purity Water Corrosion of Metals. Houston, Tex., National Association of Corrosion Engineers, 1968.

From 23rd Annual Meeting of the National Association of Corrosion Engineers, Los Angeles, Calif. See CONF-670312.

Corrosion information for two zirconium alloys, Zircaloy-2 and Zr-2½ percent Nb, oxidized in reactor radiation by water containing excess oxidizing or reducing agents is presented. Both oxidizing chemistry and damaging radiation (e.g., fast neutrons) were required to enhance the oxidation of Zircaloy-2. Oxygen in the absence of neutrons had little or no effect and neutrons did not enhance oxidation under reducing chemistry conditions. Sensitivity of Zr-2½ percent Nb alloy to radiation and water chemistry depended upon its metallurgical structure but, in general, it was sensitive to oxygen in all environments. Radiation appears to have no accelerating effect on Zr-2½ percent Nb oxidation other than that associated with oxygen production from the radiolysis of water. Addition of ammonia to the water being irradiated prevented the appearance of molecular oxygen out-reactor and reduced the oxidation of both Zircaloy-2 and Zr-2½ percent Nb. (auth)

1054 HIGH PURITY WATER CORROSION OF METALS. A Symposium Presented at 23rd NACE Conference, Los Angeles, California, March 13–17, 1967. Houston, Tex., National Association of Corrosion Engineers, 1968. 63p. (CONF-670312).

A total of 6 papers were presented at the conference. A separate abstract was prepared for each of 5 papers. The paper for which no abstract was prepared was concerned with stress–corrosion cracking in Cr–Fe–Ni alloys. (G.M.C.)

For abstracts of individual papers see: 960–962, 1052, and 1053.

1055 EFFECT OF REACTOR IRRADIATION AND SUBSEQUENT ISOTHERMAL ANNEALING ON MAGNETIC FIELD ANISOTROPY OF THIN PERMALLOY FILMS. Lezhnenko, I. V. Fiz. Metal. Metalloved., 27: 746-8(Apr. 1969). (In Russian).

Studies were made of the effects of reactor irradiations (5×10^{15}, 5×10^{16}, and 1×10^{17} n/cm^2 at neutron energies greater than 1 MeV) on thin Permalloy films with various magnitudes of magnetic field anisotropy. The films studied were sprayed on quartz bases in a vacuum of 3×10^{-5} mm Hg in a constant magnetic field applied in the plane of the film. The temperatures of the bases were 150 and 250°C, the film thicknesses were 2000 to 2200 Å, and the H_k (magnetic field strength) differed slightly from zero. Graphs of the magnetic field anisotropy during annealing at 200, 225, and 275°C are given, and it was found that the H_k of irradiated films after annealing was similar to that previously observed with non-irradiated films and that the variation of H_k as a result of annealing depended upon the relative number of voids and dislocated atoms and their mobility. (tr-auth)

1056 CHARACTERIZING THE HIGH-TEMPERATURE THERMOPHYSICAL AND THERMOCHEMICAL PROPERTIES OF IRRADIATED FUELS: PRESENT STATUS AND FUTURE NEEDS. Ogard, A. E.; Reavis, J. G.; Leary, J. A. (Los Alamos Scientific Lab., N. Mex.). pp 295-300 of Proceedings of the 16th Conference on Remote Systems Technology. Hinsdale, Ill., American Nuclear Society, Inc., 1969.

From Remote Handling and Examination in the Fast Reactor Field Meeting, Idaho Falls, Idaho. See CONF-690305.

High-temperature heat content and high-temperature differential thermal analysis apparatus are being installed in the hot cells. Their usefulness is illustrated by experiments on unirradiated fuel materials. Additional high-temperature properties of irradiated materials are proposed. (auth)

1057 EFFECT OF FAST NEUTRON IRRADIATION OF THE SUPERCONDUCTING PROPERTIES OF SOME Nb(Cb)–Ti–V ALLOYS. Pollock, J. T. A. (Tyco Labs. Corp., Waltham, Mass.); Sadagopan, V.; Gatos, H. C. Trans. Met. Soc. AIME, 245: 2350-1(Oct. 1969).

The effects of fast neutron irradiation on the superconducting properties of Nb–Ti–V alloys was studied. Cold worked Nb–Ti–V alloys were exposed to a fast neutron flux of 3.7×10^{19} n/cm^2 at 70°C. The samples were stored at room temperature for about 1 year to permit safe handling. T_c measurements were made employing a self-inductance coil technique. J_c data at 4.2°K were obtained using a four-lead resistivity method. Both T_c and J_c values decreased upon exposure of the alloys to neutron irradiation. The explanation for this behavior might be due to the type of damage produced by the bombardment. (G.M.C.)

1058 THE EFFECT OF QUENCHING, IRRADIATION DAMAGE, AND PRIOR FATIGUE ON THE CREEP OF PURE ALUMINUM. Stein, Charles (Air Force Weapons Lab., Kirtland AFB, N. Mex. New Mexico Inst. of Tech., Socorro). Trans. Met. Soc. AIME, 245: 2251-9(Oct. 1969).

The effects of several different prior treatments on the creep behavior of 99.9995 % aluminum at 260°C and 1000 psi constant stress are compared with annealed specimens. Quenching from

538°C, irradiation with 2 MeV electrons, and tension-compression room temperature fatigue damage were used to change the substructure of the specimens prior to their creep testing. The quenched and the irradiated specimens showed a larger primary and transient stage contribution to the creep curve than those specimens which were only annealed prior to creep testing. The specimen receiving prior fatigue damage at room temperature showed no first stage or transient creep when tested under identical conditions as the above specimens and had an average creep rate seven orders of magnitude lower than that of either the annealed, the quenched or the irradiated creep specimens. (auth)

1059 RADIATSIONNYE EFFEKTY IZMENENIYA PROCHNOSTI I PLASTICHNOSTI V MONOKRISTALLAKH TSINKA. (Radiation Effects on Stability and Ductility in Zinc Monocrystals). Troitskii, O. A. Moscow, Izdatel'stvo Nauka, 1968. 72p.

The basic law for the process of deformation and disintegration of zinc monocrystals during simultaneous irradiation and diffusion of metallic melts (mercury, gallium) is described. A new phenomenon related to the basic slip in zinc crystals and the anisotropy of the radiation effects on the deformation process in zinc was observed. (tr-auth)

Ceramics and Cermets

Refer also to abstracts 402, 403, 409, 455, 940–943, and 945.

1060 (BMI–1868) PROGRESS ON DEVELOPMENT OF MATERIALS AND TECHNOLOGY FOR ADVANCED REACTORS DURING JULY 1968–JUNE 1969. Annual Report, Tasks 6, 7, and 14. Keller, Donald L. (Battelle Memorial Inst., Columbus, Ohio). July 1969. Contract W-7405-eng-92. 242p. Dep. CFSTI.

Research and development on reactor materials are reported in three sections. A separate abstract was prepared for each section. (J.R.D.)

For abstracts of individual sections see: 1047, 1061, and 1099.

1061 (BMI–1868, Sect.A) URANIUM–PLUTONIUM NITRIDE FUELS FOR LMFBR APPLICATIONS. (Battelle Memorial Inst., Columbus, Ohio). 130p.

Research and development progress is reported on sintering of UN–PuN fuels, vaporization of PuN and UN–PuN systems, solid state reactions between UO_2 and U_2N_3 phases, compatibility of UN–PuN fuels with LMFBR cladding and coolant, determination method for O in Na bonding in capsules, wetting nitride fuels by Na, fabrication of PuN–UN pellets, irradiation behavior of PuN–UN fuels, EBR-II cladding, tests of PuN–UN fuels in TREAT, and neutronic behavior of PuN–UN fuels. (J.R.D.)

1062 (BMI–1870) PROGRESS ON HIGH-TEMPERATURE FUELS TECHNOLOGY DURING AUGUST 1968–JULY 1969. Annual Report. Keller, Donald L.; Chubb, Walston (Battelle Memorial Inst., Columbus, Ohio). Aug. 1969. Contract W-7405-eng-92. 182p. Dep. CFSTI.

The swelling of UO_2 is temperature-dependent, increasing with increasing surface temperatures from 1300 to at least 1750°C. Under the restraint and burnup conditions of these experiments. UO_2 swelled less than 10 wt % per 10^{20} fissions per cm^3 below 1600 and almost 30 wt % per 10^{20} fissions per cm^3 at 1750°C. Gas release was 79 to 100 percent in the temperature range from 1450 to 1750°C, and 100 percent at 1850 to 1900°C. 100 percent gas release produced a pressure of less than 30 psi within the cladding. Since this pressure is deemed too low to swell the cladding, and since the specimen swelled 8 wt %, it seems clear that swelling is caused by high-pressure bubbles prior to and probably as part of the process of gas release, possibly in the early stages of formation of columnar grains. Columnar grains of essentially uniform cross section are seen extending from the center of the UO_2 to the inside surface of the cladding at temperatures down to at least 1750°C. The greatest amount of the porosity observed in these specimens is seen as elongated, and, presumably, highly interconnected porosity at the columnar grain boundaries. It seems likely that these pores act as channels for release of fission gases swept out of the bulk fuel by the zone-refining action of lenticular pores. Since nonstoichiometric UO_2 is weaker and more volatile than stoichiometric UO_2, and since gas release may be accelerated relative to gas generation rates by deviating from stoichiometry, it appears that swelling of UO_2 fuel elements at high temperatures can be reduced by deviating from stoichiometry. The details of one mechanism of gas release from UN are described and illustrated with microstructures from irradiated specimens. It is shown that lenticular voids migrate through these fuels as a result of their high vapor pressures at high temperatures in a temperature gradient. Material contaminated with fission products evaporates from the hot side of the voids and condenses as purified fuel on the cold side. The cold side is characterized by flat, crystal facets which grow to form columnar grains oriented in the direction of the temperature gradient. Unfavorably oriented facets on these grains cease to grow, causing elongated voids to appear at the columnar grain boundaries. These elongated voids seem to be largely interconnected, so that once they have been formed they become channels for gas release as long as they remain open. The evaporation-condensation process is seen as the most rapid mechanism for collecting gas atoms and small bubbles from the bulk fuel; the interconnected channels formed at grain boundaries (or present in the initial structure) are seen as the vehicle for releasing the collected gases to external surfaces. These interconnected channels are vulnerable to closure by sintering, by swelling of the fuel, and by clogging with condensing fuel. "Saturation of swelling" in 70 percent dense UN at temperatures between 1600 and 1800°C is regarded as a dynamic balance between the swelling of gas bubbles too small to migrate or just beginning to migrate and the sintering of interconnected voids that have been formed by the migration and interaction of larger bubbles. The introduction of 20 percent porosity into UC–ZrC resulted in 70 percent gas release compared to 42 percent gas release from initially dense UC. The combination of 20 percent porosity, a 10 vol % centerline hole, and a tungsten cladding on UC–ZrC resulted in negligible diametral swelling after a burnup of 1.9×10^{20} fissions per cm^3 at temperatures between 1600 and 1820°C. A volume increase of 2.4 percent at this burnup for the tungsten-clad UC–ZrC specimen compares favorably with volume increases of about 40 percent at the same burnup in dense UC clad with tungsten-26 wt % rhenium. A liquid copper-UC cermet showed diametral increases of 4 percent at a burnup of 1.6×10^{20} fissions per cm^3 at temperatures ranging from about 1500 to 1300°C. This swelling, which is much less than that of bulk UC or solid UC cermets but is much greater than that expected of a semifluid fuel, is apparently caused by the separation of the cermet into an annular ring of solid UC on the inside surface of the cladding plus a central core of copper-rich liquid. The use of a 10-mil annular gap around a bulk UC specimen proved to be totally useless as a method of preventing cladding strain at a surface temperature of about 1600°C. The gap was closed (presumably caused by the insulating effect of the gap) at a burnup of less than 0.16×10^{20} fissions per cm^3, and swelling proceeded to a burnup of 1.7×10^{20} fissions per cm^3 at a rate as high or higher than if the gap had never existed. Uranium monocarbide has exhibited 37 percent elongation in tension in creep tests at 1400°C, and its vapor pressure is two orders of magnitude lower than those of UN and UO_2. It is considered likely that these properties separately or in combination are responsible for the different gas-release behavior of UC. Gas release from activated UC has been explained in terms of a model that accounts for the changing rates of gas release during the early parts of the process, including the so-called "burst" and the later parabolic release. The initial period involves decay of a metastable, supersaturated solution into an equilibrium system containing a second-phase precipitate of gas bubbles. This process can be described in terms of classical chemical reaction rate theory. When this chemical process approaches completion, gas release continues by diffusion from a two-phase system. This latter process can be described by classical diffusion rate methods. Gas release and diffusion during the two periods can be described by combining the models describing the two processes. An approximate model for the combined processes has been utilized to obtain the solubility limit of fission gas in UC and the chemical diffusion rates of xenon in UC. The diffusion coefficients obtained at temperatures from 1300 to 1700°C can be described by the equation: $D_{Xe} = 0.46 \exp(-78{,}000/RT)$. These diffusion coefficients are greater by about one order of magnitude than the self-diffusion coefficients for uranium in UC and greater by three or more orders of magnitude than those obtained by other investigators for the diffusion of fission gas in UC. Results of fission-gas-bubble re-solution experiments suggest that an exposure of about 8×10^{15} fissions per cm^3 is sufficient to redissolve all the fission-gas-bubble nuclei produced by an initial exposure to 1.5×10^{16} fissions per cm^3 followed by an anneal of 24 hr at 1600°C to form bubble nuclei. An atomistic model of swelling of bubbles and fuels is being developed using the fundamental chemical principles which indicate that stationary fission-gas bubbles can grow by accretion of new gas atoms or by dissolution of the smaller bubbles and growth of a lesser number of larger bubbles. Estimates of the rates of these processes suggest that the latter process is not significant out-of-pile, but it is considered that fission-induced re-solution may make it significant in-pile. Preliminary checks of the model show good agreement with data obtained in postirradiation annealing experiments. The model shows temperature-dependent swelling behavior in qualitative agreement with the actual behavior of UC in-pile. (auth)

1063 (UCRL-50004-67-1) ADVANCED SPACE NUCLEAR POWER PROGRAM. Progress Report No. 6, January-March 1967. (California Univ., Livermore. Lawrence Radiation Lab.). July 25, 1967. 84p. Dep. CFSTI.

Progress in the program is reported in three sections. A separate abstract was prepared for each section. (J.R.D.)

For abstracts of individual sections see: 993, 1064, and 2044.

1064 (UCRL-50004-67-1, pp 1-37) MATERIALS. (California Univ., Livermore. Lawrence Radiation Lab.).

The preparation of high density tungsten—over 98% of crystal density—at pressures of only 1 to 2 kbar with temperature around 1100°C is described. A tungsten alloy with 2% hafnium was hardened to an appreciable depth by combining the hafnium with nitrogen. Tests of a commercial molybdenum alloy (TZM) that showed very low creep rate in a nitrogen atmosphere at 1450°C, presumably due to nitriding of titanium and zirconium in the alloy, are reported. Tests are reported in which tungsten and rhenium showed no evidence of reaction with uranium nitride in tests at 2000°C in 10 torr nitrogen for 821 hr. The solubility of tungsten in silver at 2200°C was determined to be 2 ± 1 weight ppM. (auth)

Corrosion and Erosion

Refer also to abstract 948.

Preparation and Fabrication

Refer also to abstracts 351, 380, 977, 978, and 984.

1065 (BAW-3714-11) FABRICATION OF PLUTONIA-URANIA PELLET, SHARD, AND SPHERE IRRADIATION SPECIMENS. Ferrell, L. J. (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.). Sept. 1969. Contract AT(30-1)-3714. 26p. Dep. CFSTI.

As part of the Gel-Addition program, an irradiations testing subtask was established to evaluate the effects of heat rate and time on the restructuring characteristics of sol-gel UO_2-PuO_2 spheres and angular particles prepared from coprecipitated UO_2-PuO_2. The techniques and procedures described were used to fabricate the fuel pins for those tests. Thirty-one fuel pins were fabricated; they were divided into groups of 12 angular-particle pins, 7 sphere pins, and 12 pellet pins. The pellet pins were for a reference pin in each capsule. The fuel used in these pins consisted of UO_2-20 wt % PuO_2. In approximately half of the pins the UO_2 was enriched to 20 wt % ^{235}U. The fuel smear density on all as-fabricated pins was in the range of 82 ± 2% theoretical density. (auth)

1066 (CEA-CONF-1355) PROPERTIES OF ABSORBENT CARBONS INTENDED FOR FAST REACTOR SHIELDING. Cledat, J.; Gremion, R.; Rappeneau, J.; Degas, P. (Societe le Carbone Lorraine, Paris (France). Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [1968]. 31p. (In French). (CONF-690627-1). Dep. CFSTI (U. S. Sales Only).

From Conference on Nuclear Corrosion, Paris, France.

Different types of absorbent carbons containing rare earths or boron (calcium metaborate or boron nitride) were prepared for the neutron shield of the fast neutron reactor PHENIX. The process of manufacture and the physical properties of these absorbent carbons are discussed. The changes in physical properties by neutron irradiation were determined at the irradiation temperature of 600°C and for doses up to 2×10^{21} n/cm^{-2}. (auth)

1067 (ORNL-4422, pp 183-202) DEVELOPMENT OF THE THORIUM FUEL CYCLE. (Oak Ridge National Lab., Tenn.).

Topics covered include: preparation of ThO_2-$^{233}UO_2$ fuel for HTLTR, demonstration of the engineering-scale production of ThO_2-UO_2 microspheres, drying and firing of microspheres, and ^{233}U storage and distribution. (M.C.G.)

1068 (ORNL-4422, pp 203-29) SOL-GEL PROCESSES FOR THE URANIUM FUEL CYCLE. (Oak Ridge National Lab., Tenn.).

Research is reported on preparation of UO_3 sols by solvent extraction, UO_2-PuO_2 and PuO_2 sol-gel process development, preparation of UO_2-PuO_2 and PuO_2 materials, drying and firing of microspheres, development of high-performance fuel materials, and plutonium storage. (M.C.G.)

1069 (ORNL-4422, pp 239-51) SPECIAL SOL-GEL PROCESSES. (Oak Ridge National Lab., Tenn.).

Applications of sol-gel methods to the preparation of materials are described. Topics covered include: scaleup of the precipitation-washing-peptization sol process, incorporation of carbon into metal oxide sols, preparation of porous oxides, and microsphere forming. (M.C.G.)

1070 CONCERNING THE INTERACTION OF ZrO_2 WITH NbC. Zverev, G. L. Izv. Akad. Nauk SSSR, Metal., No. 4, 253-4(July-Aug. 1969). (In Russian).

A metallographic investigation of the zones of the reaction diffusion between ZrO_2 and NbC after heating in vacuum at 2100°C for 6 hrs indicated the presence of five phases: $Zr_{0.7}Nb_{0.3}(O)$, $Zr_{0.25}Nb_{0.75}(O,C)$, $Zr_{0.68\pm0.40}Nb_{0.32\pm0.60}(C,O)$, $NbZr_{0.05}$(trace C,O), and $Nb(Zr)_2C$. (tr-auth)

1071 CERMET ALLOYS OF RHENIUM WITH YTTRIUM HEXABORIDE. Samsonov, G. V.; Kondratov, I. Ya. (Inst. of Problems in Material Studies, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR, No. 8, 87-91(Aug. 1969). (In Russian).

The alloys of rhenium with yttrium hexaboride were prepared by powder metallurgy and their phase composition was determined. Physical properties of the alloys were investigated and their thermal emission properties are discussed from the point of view of the possibility of electronic exchange between adsorbed atoms of yttrium and backing. The exchange results in stabilization of stable electronic conditions in the system adsorbent-adsorbat. (auth)

1072 NEW TYPES OF REFRACTORY NUCLEAR FUELS. I. URANIUM MONONITRIDE. Benadik, Anton (Inst. of Nuclear Research, Rez. Czech.). Jad. Energ., 15: 325-8(Oct. 1969). (In Czech).

Uranium mononitride is a potential fuel material for slightly enriched power reactors. The U-N system is briefly described. About 40 g of UN was prepared in the laboratory. Some analytical, x-ray, and ceramographic methods of the phase control of the prepared materials are presented. Atmospheric corrosion of sintered pellets of UN in dry or moist air, nitrogen, and argon was small. The weight increase after 200 days storage was smaller than 0.05 mg/cm^2. The thermograms of the reactions of UN powders with dry and moist air and CO_2 are discussed. (auth)

1073 IMPROVEMENTS IN OR RELATING TO PRODUCTION OF PARTICULATE REFRACTORY MATERIAL. North, John Malcolm (to UKAEA). British Patent 1,164,810. Sept. 24, 1969. Filed Dec. 11, 1967.

A process is described for the production of particulate ceramic materials of spherical form and size 50 to 2,500 μ. These materials may comprise oxides, carbides, nitrides, and phosphides, including those of interest as nuclear fuels. The process can also be applied to refractory metals such as W. An arc is established between an electrode and a water-cooled crucible into which is fed the refractory material and which is rotated about its axis. The arc-melted material is flung from the crucible and is allowed to solidify without substantial contact with a solid surface. The particles have an equiaxed grain structure, and density 98% theoretical. A reduced pressure Ar atmosphere may be employed. The crucible is provided with a housing spaced so that the molten material solidifies before contacting the housing. (UK)

1074 ELECTRIC CONDUCTIVITY OF PURE AND DOPED Dy_2O_3 AND Gd_2O_3. Macki, James Michael. Columbus, Ohio, Ohio State Univ., 1968. 167p.

Thesis.

The ac conductivities of pure, ThO_2-doped, and CaO-doped Gd_2O_3 and Dy_2O_3 were measured between 800 and 1400°C at oxygen pressures between 1 and 10^{-20} atm. Pure oxygen at reduced pressures was used above 10^{-7} atm while a hydrogen-water vapor-argon system was utilized to achieve oxygen activities below 10^{-7} atm. Emf measurements were made using galvanic cells of the form: Me-MeO/$MO_{1.5}$/Mé-MéO, where Me-MeO and Mé-MéO are dissimilar metal-metal oxide reversible electrodes. X-ray analyses of pure and doped $GdO_{1.5}$ and $DyO_{1.5}$ were made. (TSS) (Diss. Abstr. Int., B)

1075 MOLTEN SOLUTION GROWN POTASSIUM SODIUM BARIUM NIOBATE CRYSTALS WITH A TUNGSTEN BRONZE-TYPE STRUCTURE. Giess, E. A.; Scott, B. A.; O'Kane, D. F.; Olson, B. L.; Burns, G.; Smith, A. W. (IBM Watson Research Center, Yorktown Heights, N. Y.). Mater. Res. Bull., 4: 741-4 (Oct. 1969).

Large crystals of the $NaBa_2Nb_5O_{15}$-type with K substitutions for Na have grown in unseeded molten solutions fluxed with excess alkali carbonates. Curie temperatures and phase match temperatures of these crystals were decreased by the substitution of K for Na. Crystal compositions lie in the ternary $NaNbO_3$-$KNbO_3$-$BaNb_2O_6$ system and were proportionately $BaNb_2O_6$-rich as was

the case for crystals pulled from nominally stoichiometric melts. The crystals exhibited 50 to 100 μ regions which were optically uniform. (auth)

1076 A PROCESS FOR THE PRODUCTION OF SPHERICAL OXIDIC AND CARBIDIC PARTICLES. (to Nukem Nuklear-Chemie und-Metallurgie Gesellschaft mbH). British Patent 1,169,210. Oct. 29, 1969. Priority date Dec. 31, 1965, Germany.

A process is described for production of spherical particles of uranium and/or thorium and/or plutonium oxides in which hexamethylene tetramine is added to the aqueous solution containing the actinide oxide sol to effect gelation of the sol by release of ammonia The sol is then introduced dropwise into a liquid immiscible with water where it solidifies to form spherical particles. (J.R.D.)

Properties Evaluations

Refer also to abstracts 986, 995, 1000, 1014, 1016, 1019, 1024, 1030, and 2070.

1077 (BNWL-1180) A COMPREHENSIVE BIBLIOGRAPHY OF LITERATURE PUBLISHED BEFORE 1969 PERTAINING TO DIELECTRIC PROPERTIES OF Al_2O_3, BeO, HfO_2, MgO, SiO_2, AND ThO_2. Keeton, S. C.; Schemmel, R. R.; Bates, J. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 1969. Contract AT(45-1)-1830. 37p. Dep. CFSTI.

A bibliography containing references to articles on the dielectric properties of Al_2O_3, BeO, HfO_2, MgO, SiO_2, and ThO_2 is presented. The references were selected by a search of Bibliography of High Temperature Chemistry and Physics of Materials, January 1960 through June 1968; Chemical Abstracts, 1907 through 1968; and Nuclear Science Abstracts, 1948 through 1968. (J.R.D.)

1078 (BNWL-1181) A COMPREHENSIVE BIBLIOGRAPHY OF LITERATURE PUBLISHED BEFORE 1969 PERTAINING TO ELECTRICAL CONDUCTION IN Al_2O_3, BeO, HfO_2, MgO, SiO_2 AND ThO_2. Keeton, S. C.; Schemmel, R. R.; Bates, J. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 1969. Contract AT(45-1)-1830. 57p. Dep. CFSTI.

A bibliography is presented on the electric conductivity of ceramic materials which represent the most attractive candidates for high temperature electric insulation. The literature surveyed included Chemical Abstracts (1907 through 1968), Nuclear Science Abstracts (1948 through 1968), and the Bibliography of High Temperature Chemistry and Physics of Materials in the Condensed State (1960 through mid-1968). The references are arranged in sections under the following headings: alumina, beryllia, hafnia, magnesia, silica, thoria, and "other selected metal oxide insulator and general articles." Approximately 520 references are included. (L.C.L.)

1079 (BNWL-CC-1490) NON-STOICHIOMETRY EFFECTS ON THE MELTING HEAT RATING FOR UO_2-25 w/o PuO_2, FAST FUELS. Christensen, J. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 3, 1968. 12p. Dep. CFSTI.

Effects of departures from stoichiometry on the linear heat rating required to initiate melting in UO_2-25 wt % PuO_2 fuels were measured. Reducing the oxygen-to-metal (O/M) ratio from 2.00 to 1.99 caused a 3.6% decrease in melting heat rating; further reduction to O/M = 1.94 resulted in a 5.5% decrease. Results are compatible with laboratory measurements of thermal conductivity and melting point. Changes in melting heat rating with O/M are too small to justify a post-sintering heat treatment to achieve an optimum composition. Results also suggest relaxing clearances on FTR fuel composition from the O/M = 1.98 ± 0.01 presently stipulated. (auth)

1080 (GAMD-9478) REFABRICATION COSTS FOR HTGR FUELS CONTAINING THORIUM-DILUTED ^{233}U PARTICLES. Stelling, H. E. (Gulf General Atomic, Inc., San Diego, Calif.). Sept. 15, 1969. Contract AT(04-3)-167. 21p. Dep. CFSTI.

Refabrication of HTGR fuels containing Th-diluted ^{233}U fissile particles and ^{235}U particles is described. Information is included on refabrication plant design, cost, and manufacturing. (J.R.D.)

1081 (GEMP-709) STUDIES ON THE STABILIZATION OF UO_2 WITH Y_2O_3 ADDITIONS. Bartram, S. F.; Fitzsimmons, E. S. (General Electric Co., Cincinnati, Ohio. Nuclear Systems Programs). Sept. 1969. Contract AT(40-1)-2847. 13p. Dep. CFSTI.

The stabilizing effect of certain R_2O_3 additives on UO_2 probably occurs by inhibiting vaporization of $UO_2 + O_2$ from the surface of the solid particles. The lower vapor pressure of Y_2O_3 at the surface of the specimens would satisfactorily explain the results. Under free vaporization conditions, the oxygen-to-uranium ratio decreases at a rate determined by vaporization of urania which is controlled by surface composition. In tantalum capsules the oxygen can diffuse from the pellet through the tantalum until the oxygen activities inside the capsule and in the gas stream are equal. Analysis of these UO_2 solid solutions is very difficult. The free metal and oxide phases will oxidize independently, but the composition of the fluorite solid solution changes with time and temperature by disproportionation to α-U_3O_8 and a FCC phase richer in Y_2O_3. Furthermore, other phases may form; these make the analysis even more complicated. (auth)

1082 (JUL-594-RW) CONTRIBUTION TO THE CARBON–URANIUM–NITROGEN SYSTEM. Katsura, Masahiro (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorwerkstoffe). May 1969. 106p. (In German). Dep. CFSTI (U. S. Sales Only).

The known thermodynamic literature data on the pure components of the C–U–N system were critically analyzed. These data are translated to the U–C–N system and compared with known experimental results. Experimentally the relation between temperature, nitrogen pressure, and composition of the U(C,N) mixed crystals, which are in equilibrium with UC_2 or UC_2 + C, was determined systematically at temperatures of 1800°C. The solubility of nitrogen in the UC_2 phase was established. The arc melts of U–C alloys in nitrogen atmosphere were investigated. (tr-auth)

1083 ELASTIC AFTEREFFECT DURING COLD PRESSING OF METAL CARBIDE MIXTURES. Petrova, E. M.; Shcherban, N. I.; Sleptsov, V. M. (Inst. of Problems in Materials Studies, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR, No. 8, 34-40(Aug. 1969). (In Russian).

The effects of pressing pressure and carbide content on the elastic effect of metal carbides were investigated. The dependence obtained previously was confirmed. It is shown that the constants of this dependence depend on the physico-mechanical properties of the charge components. The ratio between axial and radial elastic effects is studied. (auth)

1084 ISOTOPE EFFECT OF CARBON DIFFUSION IN AN Fe–Si ALLOY. Wuttig, M.; Yen, E. T. (Univ. of Missouri, Rolla). J. Phys. Chem. Solids, 30: 2269-76(Sept. 1969).

The isotope effect of carbon diffusion in dilute iron-silicon alloys containing ^{28}Si and ^{30}Si was measured below room temperature using the disaccommodation technique. The time dependence of the reluctivity was analyzed in terms of two relaxation processes which are due to the reorientation of carbon interstitials in Fe–Fe and Fe–Si sites, respectively. The ratio of the relaxation times of the two carbon isotopes ^{13}C and ^{12}C(τ_{13}/τ_{12}) is 1.037 for the former and 1.007 for the latter process in the Fe + ^{28}Si alloy. The ratios of the relaxation times of the same carbon isotope ^{12}C contained in a dilute Fe + ^{30}Si and in a dilute Fe + ^{28}Si alloy (τ_{30}/τ_{28}) are 0.995 and 1.020 for the two processes mentioned. These results demonstrate clearly the many body aspects of the diffusional process. (auth) (UK)

1085 INVESTIGATION OF THE DEFORMATION DURING SINTERING OF RAW MATERIALS FROM FINE-GRAINED ZIRCONIUM DIOXIDE. Orlova, I. G.; Kainarskii, I. S.; Alekseenko, L. S. Ogneupory, No. 6, 46-51(June 1969). (In Russian).

The sintering deformation of fine-grained samples of zirconium dioxide, first stabilized with calcium oxide (cubic) and the deformations occurring during simultaneous stabilization of raw ZrO_2 with additions of CaO, Y_2O_3, CeO_2, and MgO added in equal quantities were investigated. The effect on the deformation of raw ZrO_2 mixed with 10 to 50% of ZrO_2 obtained by decomposition of zirconium nitrate was also investigated. The total content of CaO in this mixture was 3 wt %. The method of preparation of the sample from fine-grained zirconium dioxide, stabilized with additions of CaO, Y_2O_3, and CeO_2 by sintering, did not reduce the deformation with respect to the method of preparing samples from completely or partially stabilized materials. (tr-auth)

Structure and Phase Studies

Refer also to abstracts 1040 and 1484.

1086 (GA-9433) RESEARCH ON GRAPHITE. Annual Report, May 15, 1968–May 14, 1969. Engle, G. B.; Bokros, J. C.; Price, R. J. (Gulf General Atomic, Inc., San Diego, Calif.). June 17, 1969. Contract AT(04-3)-167. 165p. Dep. CFSTI.

Results of investigations of relations between the properties, microstructure, and irradiation behavior of carbonaceous and graphitic materials required for high-temperature reactors are summarized. Efforts during the report period were devoted to

research on properties and structures of carbon and graphites, and to studies of radiation effects on these structures and properties. (J.R.D.)

1087 (LA-4213-TR) PHASE FORMATION ACCOMPANYING THE INTERACTION OF TRANSITION METALS WITH CARBON IN THIN LAYERS. Babad-Zakhryapin, A. A.; Gert, L. M.; Rogozin, V. D. Translated for Los Alamos Scientific Lab., N. Mex.), from pp 427-34 of STI/PUB-162. 7p. (CONF-670915-10). Dep. CFSTI.

From Symposium on Thermodynamics of Nuclear Materials with Emphasis on Solution Systems, Vienna, Austria.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 31506.

1088 (ORNL-TM-2507) OPTICAL SPECTRA OF THE COBALT(II) ION AT SITES OF APPROXIMATELY OCTAHEDRAL SYMMETRY IN SEVERAL CHLORIDE CRYSTALS. Gilmore, Forrest Cubley (Oak Ridge National Lab., Tenn.). July 1969. Contract W-7405-eng-26. 139p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

The optical spectra have been obtained of several crystals containing the Co^{2+} ion in an approximately octahedral environment of chloride ions. The crystals studied were $CsCoCl_3$, $RbCoCl_3$, $CsMgCl_3:Co^{2+}$, $KMgCl_3:Co^{2+}$, $CsCdCl_3:Co^{2+}$, $MgCl_2:Co^{2+}$, $CdCl_2:Co^{2+}$, and $LiCl:Co^{2+}$. A modified Bridgman technique was used to grow large single crystals of all the compounds except $RbCoCl_3$ and $CsCoCl_3$. Very thin polycrystalline films of these two compounds were used. The spectra covered the energy region from 4000 to about 30,000 cm^{-1} and were measured at room temperature to approximately 5°K. Spectra of $CsCoCl_3$ were also obtained above room temperature, up to the melting point of the compound. The spectra are interpreted and correlated using four-parameter ligand field theory and appear to be consistent with the assumption of octahedral symmetry about the Co^{2+} ion. An interpretation of the previously reported spectrum of $CoCl_2$ in the 650 to 2000 cm^{-1} energy region is presented which results in the value of 420 cm^{-1} for ζ, the spin-orbit coupling constant, for $CoCl_4^{=}$. A procedure which can be used consistently for all the spectra is developed and used to obtain values of the other three ligand field parameters by least squares fitting of the observed spectra. The procedure requires assignment of only three spin-orbit levels—one from the $^4T_{2g}(F)$ multiplet, one from the $^4T_{1g}(P)$ multiplet, and one from the $\Gamma_8(^4T_{1g},P)$ level. The electrostatic repulsion parameter B is found to be reduced about 80% from its free-ion value and the C/B ratios obtained by the fitting procedure range from 4.12 to 4.44. For the series of compounds $CsMgCl_3$, $RbCoCl_3$, $MgCl_2$, $LiCl$, and $CdCl_2$, the change in Dq correlates roughly with the change in bond distance to the nearest neighbor shell of chloride ions. Anomalously low values of Dq are obtained for three of the compounds. For $CsCoCl_3$, the low Dq value is attributed to error in locating the center of the $^4T_{2g}$ band. The low Dq value obtained in $KMgCl_3:Co^{2+}$ is attributed to contamination by K_2CoCl_4. The low Dq value obtained in $CsCdCl_3:Co^{2+}$ cannot be explained at present. It appears that the $^4T_{2g}$ band is principally magnetic dipole in nature, and it is suggested that the fine structure of the $^2T_{1g}(P)$ band at low temperatures is due to both electric and magnetic dipole transitions. The higher energy doublet bands are considerably more pronounced in the spectra of the pure compounds as compared to the doped crystals. This observation is attributed to exchange effects in the pure compounds. (auth)

1089 (Y-1691) FORMATION OF SOLID SOLUTIONS OF THE METALS OF GROUP 11B WITH BORON, AND THE DEFORMATION MECHANISMS, DISLOCATIONS, AND TWINNING IN BORON. Holcombe, C. E. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Oct. 24, 1969. Contract W-7405-eng-26. 41p. Dep. CFSTI.

By the formation of a solid solution of zinc in boron, it was possible to observe internal structures in boron deformed by autoclaving. Interaction of slip systems, cleavage cracks, dislocation and slip-plane pileup, accommodation bands, annealing twins, low-angle subgrains from dislocation interaction, and primary recrystallized subgrains were found to occur in boron. Mechanical twinning was not observed. (auth)

1090 IRON-BORON SYSTEM DIAGRAM. Portnoi, K. I.; Levinskaya, M. Kh.; Romashov, V. M. (Lenin Research Inst. of Aviation Materials, Moscow). Porosh. Met., Akad. Nauk Ukr. SSR, No. 8, 66-70(Aug. 1969). (In Russian).

The iron-boron system diagram was investigated within the whole range of concentrations by thermal, microstructure, x-ray diffraction, and x-ray spectrum analyses. The existence of the new compound FeB_n containing ~95 at. % of boron was established. A new variant of the iron-boron system diagram is suggested within the whole range of concentrations. (auth)

1091 X-RAY STRUCTURAL ANALYSIS OF THE TUNGSTEN-MANGANESE-CARBON SYSTEM. Telehus, V. S. Visn. L'viv. Derzh. Univ., Ser. Khim., No. 9, 29-33(1967). (In Russian).

An x-ray structural analysis of W-Mn-C alloys obtained by hot pressing confirmed the existence of ternary carbides W_3Mn_3C with the cubic lattice of η_1-carbide and WMn_xC_y with a hexagonal lattice of the $W_3Co_3C_4$ type. Also found in the analysis was the carbide $(W,Mn)_2C$ of variable composition whose hexagonal lattice constants at a content of 20 at.% W, 45 at.% Mn, and 35 at.% C are equal to a = 2.795 A, c = 4.490 A, c/a = 1.606. (JPRS)

1092 THE DIRECT OBSERVATION OF STRUCTURAL FEATURES AND DEFECTS IN COMPLEX OXIDES BY TWO-DIMENSIONAL LATTICE IMAGING. Allpress, J. G. (Univ. of Melbourne). Mater. Res. Bull., 4: 707-20(Oct. 1969).

Electron optical observations of several different mixed oxides of niobium having structures related to those of cubic rhenium trioxide and tetragonal tungsten bronze are presented. Two dimensional lattice images of suitably oriented crystals, together with electron diffraction patterns, contain a great deal of information, some of which can be immediately interpreted in terms of structural details at the unit cell level and crystal defects. The technique provides results which are particularly relevant to the problems of nonstoichiometry and order-disorder in these systems. (auth)

1093 REGION OF EXISTENCE AND CRYSTALLINE PARAMETER FOR THE FLUORITE PHASE IN THE SYSTEM ZrO_2-CeO_2-Y_2O_3. Forestier, Michel; Robert, Guy; Caillet, Marcel; Deportes, Charles (Laboratoire d'Etude des Reactions Chimiques et Electrochimiques Minerales, Grenoble, France). Mater. Res. Bull., 4: 727-40(Oct. 1969). (In French).

200 samples of miscellaneous compositions were prepared by sintering mixed oxides at 1850°C. The crystallographic studies were made at room temperature. The influence of average cationic radius and oxygen ion vacancy concentration on the limit of stabilization of the fluorite phase and its crystallographic parameter are discussed. (auth)

1094 PHASE RELATIONS IN REFRACTORY METAL-OXYGEN SYSTEMS. Chang, Luke L. Y. (Cornell Univ., Ithaca, N. Y.); Phillips, Bert. J. Amer. Ceram. Soc., 52: 527-33(Oct. 21, 1969).

The literature on the tungsten-oxygen, molybdenum-oxygen, tantalum-oxygen, and niobium-oxygen systems is reviewed. Wherever possible, stability relations among oxides in each system are illustrated by diagrams. The discrepancies and confusion in the literature of refractory metal oxides are mainly due to the poorly defined conditions under which the oxides have been prepared and studied. If a metal-oxygen system is considered in terms of the phase rule, two degrees of freedom are possible where one condensed phase (solid or liquid) is present. It is noted that if two condensed phases exist in equilibrium, the oxygen partial pressure is constant at a fixed temperature, and the oxygen isobar must be a straight line connecting the compositions of phases in equilibrium. The importance of oxygen in the gas phase to the formation of refractory metal oxides is emphasized. A quantitative treatment of this problem must be included in any metal-oxygen work if stability of the oxide is to be properly defined. (auth)

1095 QUATERNARY SYSTEM U-C-O-N AT 1700 C. Henry, Jack L.; Blickensderfer, Robert (Bureau of Mines, Albany, Oreg.). J. Amer. Ceram. Soc., 52: 534-9(Oct. 21, 1969).

The quaternary system U-C-O-N was examined at 1700°C by microstructural and x-ray analyses of sintered powder compacts. Subliquidus phase relations, oxycarbonitride solid-solution lattice parameters, and equilibrium pressures of N_2 and CO were studied. Although the emphasis was on the solid-solution field in the uranium monocarbide-mononitride-monoxide region, phase fields in the uranium-rich region and the carbon-nitrogen-oxygen-rich region were examined. Nineteen fields were established experimentally, and their boundaries were located. Two other fields are postulated on the basis of phase rule and topological requirements. An isothermal phase diagram of the system is proposed. (auth)

1096 SCANNING ELECTRON MICROSCOPY OF BeO WHISKERS FORMED ON THE SURFACE OF BURNING BERYLLIUM DROPLETS. Prentice, Jack L. (Michelson Labs., China Lake, Calif.). J. Amer. Ceram. Soc., 52: 564-5(Oct. 21, 1969).

Experiments are described in which a scanning electron microscope is used to record micrographs of the evolution involving randomly growing ill-formed BeO on a spongy Be substrate, growth of hexagonal BeO whiskers on a molten droplet of Be at 1556°K, and encapsulation of the Be droplet by molten BeO at 2820°K. All BeO

whiskers disappear when the droplet exceeds the melting point of the oxide. (J.R.D.)

1097 COMMENTS ON "DEPENDENCE OF FLOW STRESS ON NONSTOICHIOMETRY IN OXYGEN-RICH URANIUM DIOXIDE AT HIGH TEMPERATURE." Yust, C. S.; McHargue, C. J. (Oak Ridge National Lab., Tenn.). J. Amer. Ceram. Soc., 52: 568-9 (Oct. 21, 1969).

Experiments are described in which the generation and propagation of dislocations in stoichiometric UO_2 single crystals were studied. Extensive dislocation generation was found to occur at a compressive strain of 0.01 in crystals oriented for glide on one of the {100} ⟨110⟩ systems. A strong effect of impurities on the flow stress was revealed. This was thought to arise from point defect-impurity-dislocation interactions and consequent charge variations on the dislocations. (J.R.D.)

1098 REPLY BY J. S. NADEAU [ON MEASURING FLOW STRESS OF UO_2]. Nadeau, J. S. (General Electric Research and Development Center, Schenectady, N. Y.). J. Amer. Ceram. Soc., 52: 569-70(Oct. 21, 1969).

In discussions of UO_2 flow stress it is pointed out that strain increases the flow stress of this material. It is also noted that experimental data are evidence that strength of UO_2 is a function of stoichiometry. It is felt that none of the models adequately fit the evidence of deformation mechanisms associated with UO_2 and that impurities are not important factors in flow stress values for this material. (J.R.D.)

Radiation Effects

Refer also to abstracts 1056, 1065, 1086, and 1969.

1099 (BMI-1868, Sect.C) CREEP OF REACTOR FUEL MATERIALS. (Battelle Memorial Inst., Columbus, Ohio). 82p.

Progress is summarized on development of in-pile creep capsules, fabrication of UO_2 creep specimens, fabrication of PuO_2–UO_2 creep specimens, creep testing PuO_2 and UO_2, and on studies of PuO_2–UO_2 stoichiometry. (J.R.D.)

1100 (BNWL-1056-B) IRRADIATION OF GRAPHITE AT TEMPERATURES OF 300 TO 1200 °C. Helm, J. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 1969. Contract AT(45-1)-1830. 183p. Dep. CFSTI.

Irradiations of a large variety of graphites have been conducted at temperatures from 300 to 1200°C to maximum neutron fluences of 2.7×10^{22} nvt (E > 0.18 MeV). As temperatures and neutron fluences increase, bulk expansion of the graphite becomes the controlling behavior in all orientations. Materials which are well graphitized, highly crystalline, isotropic, and have a high CTE show the lowest contraction at moderate fluences. The data and information presented comprise the appendices to BNWL-1056A and include details of sample selection, experimental procedures, experimental results, and supplemental figures. (auth)

1101 (GA-9600) INTERPRETATION OF DIMENSIONAL CHANGES CAUSED IN PYROLYTIC CARBON BY HIGH-FLUENCE NEUTRON IRRADIATION. Bokros, J. C.; Koyama, K. (Gulf General Atomic, Inc., San Diego, Calif.). June 1, 1969. Contract AT(04-3)-167. 35p. Dep. CFSTI.

Irradiation-induced dimensional changes in a variety of pyrolytic carbons at 900 to 1300°C showed that during irradiation, the rate at which the specimens changed dimensions accelerated. The accelerations were most pronounced in dense, isotropic carbon and were accompanied by the generation of pores in the structure, which caused a volume expansion. The data obtained at ~900°C suggested that the accelerations were due primarily to a degradation in crystal structure that enhanced the instability of the crystallites. At the higher irradiation temperatures, increases in anisotropy contributed significantly to the accelerations. The volume expansions, the degradation of the crystal structure, and changes in thermal conductivity were all less for irradiations above 1200 than at 1000°C. These observations, together with the increases in anisotropy, are believed to be manifestations of the fact that the intercrystallite irradiation creep rate is substantially higher at irradiation temperatures above 1200 than at 1000°C. High creep rates provide an effective mechanism which relaxes the stresses that are generated between adjacent, misaligned crystallites during irradiation. (auth)

1102 (GEMP-682) FISSION PRODUCT TRANSPORT PROCESSES IN REFRACTORY METAL FUEL SYSTEMS. Conn, P. K.; Duderstadt, E. C. (General Electric Co., Cincinnati, Ohio. Nuclear Systems Programs). May 1969. Contract AT(40-1)-2847. 74p. Dep. CFSTI.

Broad studies were conducted on refractory metals and refractory metal-clad W-CO_2 cermet core fuel elements to gain a better understanding of fission product transport processes in these systems and their effect on leak-free life of such fuel elements. At irradiation temperatures up to 1600°C and burnups to $\sim 7 \times 10^{19}$ fissions/cc of cermet core, most of the fission gas was retained in the W and UO_2, "dissolved" in the lattice and/or trapped in isolated pores. The observed distribution was 65 to 80% in UO_2 particles, and 14 to 23% in the W-matrix, with 5 to 15% of the gas having mobility in connected pores and channels. The mobile gas was released from the UO_2 phase at temperatures exceeding 650 to 700°C. The dominant factors which determine the leak-free life of refractory metal clad-cermet core fuel element specimens having relatively large cladding-to-core ratios (0.12 to 1.1) appeared to be burnup, irradiation temperature, and the creep-rupture properties of the core and cladding. Demonstrated leak-free life, of small nonprototypic fueled assemblies, is dependent on cladding material; the order of decreasing leak-free life was: Ta–10W, Ta and W–30Mo–30Re (atom percent). (J.R.D.)

1103 (WARD-3791-16) THERMAL FLUX IRRADIATION STUDIES OF (U,Pu)C FUEL DESIGN, FABRICATION AND REACTOR INSERTION OF FUEL PINS AND CAPSULES. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Apr. 1969. Contract AT(30-1)-3791. 34p. Dep. CFSTI.

Nine fuel pins with 3 variations of (U,Pu)C pellets and bonded with liquid sodium were designed and fabricated for irradiation in a thermal neutron flux. The objective of the experiment is to evaluate the in-pile performance of sodium-bonded carbide fuel pins. The variations in fuel include $Cr_{23}C_6$-modified, Fe-modified, and unmodified pellets of a nominal 89% of theoretical density. The cladding is 316 and 304 stainless steel. Three fuel pins are stacked axially in each of 3 instrumented double-containment capsules. Nominal irradiation parameters include fuel power ratings up to 30 kW/ft and target burnups to 50,000 MWd/t. Control of the experiment is accomplished by monitoring capsule thermocouples and subsequent adjustment of in-reactor facility tubes to maintain near-constant power rating on the high-power pins. (auth)

1104 (WARD-3791-40) URANIUM-PLUTONIUM CARBIDE DEVELOPMENT. Quarterly Progress Report for the Period Ending June 30, 1969. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Aug. 1969. Contract AT(30-1)-3791. 54p. Dep. CFSTI.

Experiments were undertaken to provide additional information on pressing and sintering of plutonium–uranium carbides. Work on the fabrication of pellets for EBR-II irradiation was completed. Routine characterization of potential plutonium–uranium carbide fuel batches continued. A quantity of scrap material from a variety of sources was oxidized and sampled for plutonium and uranium contents. A second group of carbide pellets was examined to assist in phase identification and to determine the degree of homogeneity. Effort was directed to the completion of fabrication of fuel irradiation test capsules for insertion in EBR-II. To obtain post-irradiation axial clad strain data for Type 316 stainless steel cladding, a fiducial marking technique was applied to the outside diameters of all fuel pins except three previously completed. The x-radiographs of three (U,Pu)C capsules were received. The radiographs are complementary to the neutron radiographs completed previously, but the lack of edge clarity prevented precise measurement of pellet dimensions for swelling estimates. Fabrication of nine (U,Pu)C capsules was completed. Eight of the nine have been prepared for shipping while one will be withheld pending further evaluation of the fuel. (auth)

1105 DIFFERENT HARDENING BEHAVIOR OF LOW AND HIGH DOSE γ-IRRADIATED NaCl SINGLE CRYSTALS. Lerma, I. S.; Agullo-Lopez, F. (Junta de Energia Nuclear, Madrid). Acta Met., 17: 1459-65(Dec. 1969).

The characteristics of glide at the onset of plastic flow have been determined by etch-pit observations for γ-irradiated NaCl and they have been correlated with stress–strain behavior. A marked difference between low ($\lesssim 10^6$ R) and high ($\gtrsim 10^6$ R) dose irradiated samples has been found. The variation of the yield stress σ_0 with dose has been determined for both regions of dose. For low dose irradiations a definite hardening exists which can be correlated with the first and second stages of the F-center coloring curve. In particular, the experimental data suggest that only the slow component of the first stage F-coloring contributes to the hardening. On the other hand, it has been observed that the bleaching of F-centers is associated with a relatively large (~40%) decrease in the radiation-induced hardening. For high dose irradiations, yield stress data confirm a Fleischer-type law as observed for other alkali halides. The distinctive nature of hardening in each region of dose has been clearly demonstrated by indentation experiments. (auth)

1106 THERMAL CONDUCTIVITY OF FAST NEUTRON IRRADIATED GRAPHITE. Taylor, R. (Univ. of Manchester, Eng.); Kelly, B. T.; Gilchrist, K. E. J. Phys. Chem. Solids, 30: 2251-68 (Sept. 1969).

Recent studies of changes in crystal dimensions and of crystal lattice parameters following fast neutron irradiation over a wide range of doses and temperatures were interpreted in terms of two types of interstitial defect and three types of vacancy defect. It is possible to estimate the concentration of interstitial atoms and vacancies in each type of defect as a function of neutron dose and irradiation temperature. The relative concentration of each type depends on the irradiation conditions, and the annealing characteristics of each defect type are different. Measurements were made of the temperature dependence of the principal thermal conductivities of highly oriented pyrolytic graphite irradiated to selected doses at certain temperatures, and of changes in thermal conductivity during post-irradiation annealing. These changes are analyzed in detail using a simplified theory of phonon scattering in the graphite lattice and the defect concentrations obtained from the analysis of dimensional changes. More detailed published information on the changes of thermal resistivity of reactor grade graphite at ambient temperature is also successfully analyzed by the theory. Analysis of these data yields meaningful scattering parameters and gives estimates of defect sizes in reasonable agreement with those obtained by other workers. With regard to the temperature dependence of the data on pyrolytic graphite, in the direction parallel to the basal planes at temperatures >300°K, the results can successfully be interpreted in terms of the parameters obtained from the reactor grade graphite analysis. At lower temperatures the resistance is found to increase with decreasing temperature. It is concluded that this is probably due to electron phonon scattering by electronic states associated with point defects. Parallel to the hexagonal axis approximate estimates are made of the thermal resistance changes due to each type of defect. (auth)(UK)

1107 FISSION DENSITY, BURNUP, AND TEMPERATURE EFFECTS ON FISSION-GAS RELEASE FROM UO_2. Carroll, R. M.; Morgan, J. G.; Perez, R. B.; Sisman, O. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 38: 143-55(Nov. 1969).

Two cylindrical specimens of UO_2 were irradiated in the Oak Ridge Research Reactor at temperatures up to 1700°C. Both specimens were of natural enrichment uranium (0.7% ^{235}U) but one specimen was a single crystal and the other had a fine-grain microstructure. The fission-gas release from these specimens was affected by the fission density, temperature, burnup, grain growth, and the cracking of the specimens. Concentrations of fission gas produced high local stresses which contributed to the cracking of the specimens. Spherical specimens of enriched (48.7% ^{235}U), fused, polycrystalline UO_2 were irradiated to study the effect of burnup and high fission density. The spherical specimens began breaking at 1.9% uranium burnup and continued to break into smaller fragments as the burnup continued to 4.6% uranium burnup. The primary cause of breaking was fission-gas pressure within the spheres rather than thermal stresses. Equiaxed grain growth in UO_2 occurs at ~1650°C and fission gas, normally trapped in a grain boundary, can then migrate along the mobile grain boundary. The fission-gas release rate is thus greatly increased during the time of grain growth but the increase in grain size has little influence on the subsequent gas release at lower temperatures. By the defect-trap model, the effect of an increase in fission density is to create more traps within the fuel and at the same time to generate more fission gas. Thus, although the concentration of fission gas within the specimen is proportional to the fission density (at equilibrium conditions) the escape rate of the fission gas is not proportional to the concentration, unless the fission density is very low. When the fission density is very high, however, the fission tracks will intersect and the fission gas may escape as if through interconnected diffusion pipes. The fission-gas release was found to increase exponentially with fission density above 10^{14} fissions/(cm^3 sec). (auth)

1108 SOME RESULTS OF STUDYING THE BEHAVIOR OF AN IRRADIATED Zr–B ALLOY DURING ANNEALING. Davydov, E. F.; Kolesov, V. V. At. Energ. (USSR), 27: 57-9(July 1969). (In Russian).

Thin rolled samples of Zr containing 0.002 g/cm^3 of the B-10 isotope (~0.03 wt. %) were irradiated in direct contact with water at 300 to 350°C, until about 3.4 ncm^3 of He per 1 cm^3 volume of Zr had accumulated as a result of the (n,alpha) reaction. After the end of the irradiation, the structure and density changes in the samples were investigated before and after annealing at 600, 700, 800, and 1000°C. The distribution of gas between closed and open pores was also determined by noting the gas evolution on heating in vacuum. The gas begins to evolve out of the Zr at about 700°C (8.7% of the total amount of gas formed). Approximately 50% of the gas which is formed is evolved into the open porous space at 1000°C. The greater part of the gas comes out of the Zr after the first 30 to 40 minutes of annealing. A change in microstructure is noted at 800°C with a 12% drop in density at 1000°C. Thus it appears that Zr–B alloys must be limited in use to temperatures below about 700°C. (TTT)

Plastics and Other Materials

Refer also to abstracts 230, 942, and 1018.

1109 (N-69-33236) EFFECT OF RADIATION ON ELECTRICAL INSULATING MATERIALS. Hanks, C. L.; Hamman, D. J. (Battelle Memorial Inst., Columbus, Ohio. Radiation Effects Information Center). June 16, 1969. Contract NASw-1568. 59p. (NASA-CR-101129; REIC-46). CFSTI.

Information available on the effects of steady-state radiation on electrical insulating materials are compiled and summarized. The insulating materials are classified as organic or inorganic with separate sections on bulk type specimens (film, sheet, etc.), wire and cable insulation, encapsulating compounds, and connectors and terminals. It is the intent of the report to provide information for broad estimates of the effect of radiation on various insulating materials and is meant to be used as a guide in the early design stages. Detailed information as required in the terminal stages of design should be requested when details of all environmental conditions, radiation exposure rate, and total dose are known. (auth) (STAR)

1110 (ORNL-4422, pp 333-7) ASSISTANCE PROGRAMS. (Oak Ridge National Lab., Tenn.).

Tests to evaluate commercial protective coatings were continued. Eighty coatings (seven generic types) supplied by nine manufacturers are being tested by exposure to a ^{60}Co gamma source. (M.C.G.)

1111 DOSIMETRIC CHARACTERISTICS OF LiF MONOCRYSTAL. Kudelin, K. M.; Bulgakov, V. B.; Lebedev, A. A. Izmer. Tekh., No. 10, 62-3(Oct. 1969). (In Russian).

Crystals of LiF prepared by Kyropoulos' procedure in open air were studied and it was found that LiF monocrystals can be used effectively for measuring γ radiation doses in the range of 0.005 to 10^4 R at 15 keV to 1.3 MeV with the order of error of ±(15 : 17)%. (R.V.J.)

1112 NEUTRON ATTENUATION MECHANISMS IN CONCRETE SHIELDING. Greenborg, J. (McDonnell Douglas Corp., Richland, Wash.). J. Mater. Sci., 4: 251-81(June 1969).

The neutron attenuation properties of the constituent materials of concrete are reviewed. Concrete has excellent nuclear properties from the standpoint of neutron and γ-ray attenuation mechanisms and, with a proper choice of aggregates, it can be tailored to the attenuation, structural, and design problems of the device emitting such radiation. The theory of neutron interaction, moderation, and attenuation is developed and related to the materials in the concrete mix. The physical description and source of the neutrons are discussed. Results of neutron penetration studies are presented, and the methods of neutron attenuation calculation are reviewed. The heavy elements of concrete provide reasonable fast neutron attenuation (by inelastic scattering) and good thermal neutron capture. The light elements (especially hydrogen) present prevent buildup and excessive leakage of intermediate-energy neutrons. An additional factor favoring the use of concrete is its γ-ray attenuating properties. For nuclear reactors the controlling biological dose at the shield edge is the γ radiation which results from neutron capture in the inner shield regions and from the fission process in the reactor fuel. Gamma rays interact with atomic electrons, thus their attenuation is proportional to the atomic electron and material densities. Attenuation efficiency also increases with atomic mass. Thus, for shields of least volume, dense materials are desirable, preferably those containing heavy elements. Because this is not consistent with the need in materials for neutron shielding, a material is selected which fills the γ-ray and neutron requirements. Concrete has a unique mixture of heavy and light materials, and if the concrete shield is designed to reduce adequately the biological dose resulting from radiation from the reactor, the neutron leakage dose will usually be satisfactory. (BBB)

PHYSICS (GENERAL)

Astrophysics and Cosmology

1113 (STI/PUB-214(Vol.1)) CONTEMPORARY PHYSICS: TRIESTE SYMPOSIUM 1968. VOL. I. Proceedings of the International Symposium, Trieste, June 7–28, 1968. (International Atomic Energy Agency, Vienna (Austria)). 1969. 584p. (CONF-680629-(Vol.1)). IAEA $13.00.

Major fields covered by the conference include: theory of condensed matter and related problems; plasma physics, turbulence, quantum optics, and statistical mechanics; astrophysics, quasars, and pulsars; and gravitational theory and cosmology. Separate abstracts were prepared for 33 of the 48 papers. (W.D.M.)

For abstracts of individual papers see: 1114, 1143, 1185–1188, 1206, 1230–1234, 1249–1260, 1306, 1357, 1358, 1360, 1373, 1374, 1424, 1443, and 1493.

1114 INTRODUCTION AND TOPICS IN THEORETICAL ASTRONOMY. Salpeter, E. E. (Cornell Univ., Ithaca, N. Y.). pp 335-46 of Contemporary Physics: Trieste Symposium 1968. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.1); CONF-680629(Vol.1).

Some underlying reasons are discussed for the complexity of phenomena encountered in astronomy. The importance of the very small value of the "gravitational fine-structure constant" (and a few other dimensionless constants) is stressed. A few examples are given of complex problems, e.g., (1) rare phenomena like neutrino pair emission in stellar interiors; (2) highly nonequilibrium circumstances like the formation and destruction of hydrogen molecules in the interstellar gas; (3) phenomena at very high densities such as (a) the freezing of positive ions into a Coulomb lattice and (b) the formation of higher baryon states in neutron matter at densities beyond nuclear density. (auth)

Stars

Refer also to abstracts 1304, 1660, and 1748.

1115 EVOLUTION OF SUPERNOVA REMNANTS. Erkes, Joseph William. Urbana, Ill., Univ. of Illinois, 1968. 135p.

Thesis.

Observations of the supernova remnant HB21 made at a frequency of 2695 MHz are described. A contour map of the antenna temperature distribution across HB21 was constructed. The northern part of HB21 appears to be flattened as if the supernova remnant has collided with an interstellar cloud to the north. A contour map of the distribution of spectral indices across HB21 has been constructed. The spectrum of the radiation from most of the supernova remnant is relatively straight with a spectral index of +0.40. The spectral index of the northern part of the source is about +0.35. More detailed studies of this region show that the spectrum is actually curved. Several possible interpretations of the spectral curvature are suggested. A theoretical model of the supernova remnant phenomenon is developed. The model is based on the conservation of energy and takes into account the shock interaction between the expanding ejected material and the interstellar material. Four problems are studied with the aid of this model. In order to obtain information about the conditions within a young supernova remnant, a model is constructed for the supernova remnant Cassiopeia A. Other models are constructed to study the evolution of more massive Type II supernova remnants. The results of the model calculations are compared with the observed supernova remnants and predictions are made about the masses, ages, distances, radii, and expansion velocities of the remnants. In addition, models are constructed to study the effect on a supernova remnant of a collision with an interstellar cloud. Finally, a model of a Type I supernova remnant is constructed and studied. (Disser. Abstr.)

1116 VIBRATIONAL STABILITY OF PURE HELIUM STARS SURROUNDED BY PURE HYDROGEN ENVELOPES. Van der Borght, R. (Monash Univ., Clayton, Australia). Aust. J. Phys., 22: 497-503(Aug. 1969).

This paper investigates the influence of a pure hydrogen envelope on the vibrational stability of pure helium stars and establishes the limiting mass as a function of the fractional mass of such an envelope. It is found that an envelope with a mass fraction of the order of 10^{-4} will make the star vibrationally stable, even when the total mass of the star is well above the limiting mass for pure helium stars. (Australia)

1117 ASTROMETRIC AND SPECTROSCOPIC STUDY OF THE GALACTIC CLUSTER NGC 1039. Ianna, Philip Anthony. Columbus, Ohio, Ohio State Univ., 1968. 160p.

Thesis.

An observational study of the galactic cluster NGC 1039 has been carried out from two viewpoints. Spectra obtained with the 72-inch Perkins telescope at Flagstaff, Arizona yield information about the spectral types, projected rotational velocities, and radial velocities of the bright stars in and near the cluster. The MK spectral types of the brighter cluster stars lie between B8V and A0V. Especially interesting is the occurrence of three peculiar-A stars in the vicinity of the cluster. The peculiarities in the three stars are recognized by the appearance of abnormally strong silicon, silicon and chromium, and manganese lines respectively. Mean rotational velocities are higher than the field for the mean spectral type of the stars. The astrometric study combines plate material from the Allegheny and Sproul Observatories, the Allegheny material having a time base of about fifty years. (TSS)

1118 FOUR-COLOR PHOTOMETRY OF KO AQUILAE-TYPE ECLIPSING BINARIES. Barnes, Ronnie Clay. Bloomington, Ind., Indiana Univ., 1968. 122p.

Thesis.

Stromgren uv by photometry was used to determine absolute dimensions of several KO Aquilae-type eclipsing binaries. Spectrograms taken at a dispersion of 128 Å/mm were used to estimate the amount of interstellar reddening and to give independent estimates of absolute visual magnitude. The results were then compared with Kopal's assumption and Roxburgh's theory about KO Aquilae type stars. Of the fourteen systems studied only one, AR Lac, was found to possess a primary with an absolute magnitude which differed by less than one-half magnitude from that predicted by the "normal" mass–luminosity law. Hence, Kopal's assumption that the primaries are main sequence stars is no longer justifiable. The secondaries of VW Cyg, AQ Peg, RX Gem, Y Cam, and QY Aql, within the observational error, were found to be in contact with their critical inner Lagrangian surface. Hence, these stars should no longer be considered KO Aquilae-type stars. Roxburgh's theory that these systems are in a state of premain sequence contraction was found to predict significantly different ages for the primary and secondary stars. In the majority of cases, the predicted dimensions are in serious conflict with those determined from observation. (Disser. Abstr.)

1119 MAGNETIC STARS. PART II. THEORY. Stepien, Kazimierz. Postepy Astron., 17: 217-40(Sept. 1969). (In Polish).

All major aspects of the theory of magnetic stars are described. The origin of stellar magnetic fields and related theories are included: fossil, magnetism, hydromagnetic dynamo, Babcock's theory, and thermal generation amplification mechanism due to electromagnetic instability. None of these theories can describe properly the observations and the required theoretical conditions. Recent results on the relation between the angular velocity distribution inside the star and the internal structure of a star with a magnetic field are described. Existing models of magnetic stars, in particular the oscillatory and oblique rotator, are described. It seems, that both the recent theoretical and observational results are in favor of the oblique rotator theory. (auth)

1120 NONLINEAR THEORY OF PULSATION. Zytkow, Anna. Postepy Astron., 17: 241-65(Sept. 1969). (In Polish).

A short account of Christy's results on nonlinear calculations of stellar pulsations is given. (auth)

1121 SOME REMARKS ON YOUNG CLUSTERS AND PECULIAR A STARS ASSOCIATED WITH THEM. Hyland, A. R. (Australian National Univ., Canberra). Proc. Astron. Soc. Aust., 1: 14-15(Jan. 1967).

A study was made of the upper main-sequence stars in several young clusters, in an attempt to determine a well-defined effective temperature scale for the B stars, and to compare the observed atmospheric parameters with the recent theoretical evolutionary tracks in the H–R diagram. Absolute energy distributions were obtained for the program stars from photoelectric scans, and Hγ profiles determined from coudé spectra at 6.7 Å/mm. The atmospheric parameters θ_e and log g were derived by fitting these to the grid of model atmospheres. The results obtained for the stars in IC 2391 are shown, together with those for the Hyades, Sirius, and Vega. From a consideration of the atmospheric parameters of field and cluster Si λ-4200 stars, it is shown that these form a sequence along the post main-sequence evolutionary track for stars

of 5 ± 0.5 $M_\odot$. The luminosities of those silicon stars in clusters indicate that 4 $M_\odot$ is a more appropriate mass. It was concluded that the present hydrogen-line broadening theory is inadequate for the accurate determination of gravity of the hot stars. (BBB)

1122 A METHOD TO TREAT THE CONVECTIVE REGIONS IN THE EVOLVING STELLAR INTERIOR. Suda, Kazuo (Tohoku Univ., Sendai). Sci. Rep. Tohoku Univ., First Ser., 52: No. 1, 10-18(Feb. 1969).

A method is described for treating generally the convective regions in the automatic computation of stellar evolution. A generalization is done in the scope of mixing-length theory, and the necessary formulations are provided for use in the method proposed by Henyey, Forbes, and Gould (1964). (auth) (NSA of Japan)

1123 HOMOGENEOUS MODELS FOR UPPER MAIN-SEQUENCE STARS. Shibata, Yukio (Tohoku Univ., Sendai). Sci Rep. Tohoku Univ., First Ser., 51: No. 4, 95-104(Dec. 1968).

Eleven homogeneous models were constructed in the mass range from 5 to 100 in solar units for the abundance: X = 0.602, Y = 0.354, and Z = 0.044. Principal part of the code to compute the models consists of the relaxation method expressed in the formulations proposed by Henyey, Forbes, and Gould. Properties of the models are discussed in comparison with models where electron scattering is considered as a sole opacity source. Results are also compared with previously published models for the same abundance. (auth) (NSA of Japan)

1124 NONRADIAL PULSATION OF GENERAL-RELATIVISTIC STELLAR MODELS. III. ANALYTIC AND NUMERICAL RESULTS FOR NEUTRON STARS. Thorne, Kip S. (California Inst. of Tech., Pasadena). Astrophys. J., 158: 1-16(Oct. 1969).

Numerical techniques are developed for calculating the properties of the nonradial, quasi-normal pulsations of fully relativistic stellar models. These techniques are then applied to calculate, for four realistic neutron-star models, the following characteristics of the lowest few quadrupole p-type modes: the pulsation periods ($\sim 10^{-3}$ sec), the gravitational-radiation damping times ($\sim$ 1 sec), the pulsation energies ($\sim 10^{52}$ ergs), the power emitted in the gravitational waves ($\sim 10^{52}$ ergs sec^{-1}), and the shapes of the fluid motions. Analytic techniques are used to show that many, and perhaps all, of the g-type modes of a neutron star have zero frequency, if thermal pressures are negligible compared with nuclear pressures. (auth)

1125 RELATIVISTIC, SPHERICALLY SYMMETRIC STAR CLUSTERS. III. STABILITY OF COMPACT ISOTROPIC MODELS. Ipser, James R. (California Inst. of Tech., Pasadena). Astrophys. J., 158: 17-43(Oct. 1969).

In Papers I and II of this series, methods were developed for studying, within the theory of general relativity, the stability against radial perturbations of collisionless, spherical star clusters. In this paper those methods are employed to diagnose numerically the stability of specific models for compact star clusters with isotropic velocity distributions. The clusters studied are: (i) clusters of identical stars with heavily truncated Maxwell–Boltzmann velocity distributions; and (ii) clusters whose densities and isotropic pressures obey polytropic laws of index 2 or 3. The calculations show that a cluster of either type is unstable against gravitational collapse if the redshift of a photon emitted from its center and received at infinity is $z_c \gtrsim 0.5$. The cluster is stable if $z_c \lesssim 0.5$. (auth)

1126 INFRARED SPECTRA OF HIGHLY REDDENED STARS: A SEARCH FOR INTERSTELLAR ICE GRAINS. Knacke, R. F.; Cudaback, D. D.; Gaustad, J. E. (Univ. of California, Berkeley). Astrophys. J., 158: 151-60(Oct. 1969).

Infrared spectra extending to 3.5 μ were obtained of the highly reddened supergiants VI Cyg No. 12, CIT 11, and HD 183143. No absorption band at 3.07 μ stronger than 10% of the expected absorption of ice grains can be fitted to the spectra of the first two objects, and none greater than 50% to the third. Theoretical calculations were made of the absorption cross sections for pure-ice grains and for composite grains consisting of ice mantles surrounding a graphite core. New laboratory spectra of the position, strength, and shape of the ice band confirm that these calculations are valid for interstellar temperatures. It is concluded that the interstellar grains contain very little ice. (auth)

1127 STRUCTURE OF A ROTATING POLYTROPE IN THE POST-NEWTONIAN APPROXIMATION OF GENERAL RELATIVITY. Chau, Wai-yin (Brown Univ., Providence). Astrophys. J., 158: 85-9(Oct. 1969).

A variational approach based on the work of Roberts and of Krefetz is used to examine the structure of a fast-rotating polytrope with symmetry about the axis of rotation and under stationary conditions in the post-Newtonian approximation of general relativity. The effects are evaluated by means of a simple trial function. (auth)

1128 NARROW- AND BROAD-BAND PHOTOMETRY OF RED STARS. IV. POPULATION SEPARATION IN GIANT STARS. Eggen, Olin J. (Australian National Univ., Canberra). Astrophys. J., 158: 225-41(Oct. 1969).

Narrow-band (102,65,62) and broad-band (R–I) photometry of the M- and K-type giants in the Bright Star Catalogue is used to construct population discriminants for the young disk stars ($\leq 5 \times 10^8$ years), old disk stars (to about 5×10^9 years), and the older halo stars. The B–V scale collapses for stars redder than about (B–V) = +1.55 mag, but the (U–B) colors are a smoothly varying function of color temperature (blackbody) between about 6000° and 2000°. The main population discriminants are the space motion, the ultraviolet colors, and the TiO absorption. The small ultraviolet excess known for old disk dwarfs is also found in the subgiants but is very small or absent in the giants. The halo-population subgiants and giants show large values of Δ(U–B) relative to the young disk stars. The TiO absorption of young and old disk giants is indistinguishable for stars hotter than color temperatures (blackbody) of about 2500°, but the halo stars show no TiO absorption. The bolometric luminosities are very well approximated by M(102) + 1 mag. The old disk giants define a tight sequence in the (M_{bol}, T_e) plane, and this sequence differs little from that for the young disk group in the Hyades. Also, the halo giants join this sequence at color temperatures near 2800°. (auth)

1129 THE PERIODIC VARIABILITY OF 78 VIRGINIS. Preston, George W. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 158: 243-49(Oct. 1969).

The occurrence of the crossover effect, the strength of the magnetic field, Henry's k index, and the radial velocity of 78 Vir all vary periodically in a period of 3.7220d. It is argued that there is no convincing evidence for a random component in the magnetic field. (auth)

1130 THE VARIABILITY OF 21 PERSEI. Preston, George W. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 158: 251-60(Oct. 1969).

Radial velocities and line intensities in the spectrum of 21 Per vary periodically in the 2.88d photometric cycle derived by Stępień. The velocity curve for the singly ionized rare earths consists of two branches that overlap near primary light maximum and overlap again one half-cycle later, when a weak secondary light maximum may occur. The range of the velocity variation is about 30 km sec^{-1}. The velocity variation for Ti II and Mn II resembles those for the rare earths, while lines of Si II, Sr II, and Fe II yield velocity curves of small amplitude with double waves. The velocity curve for Cr II lines varies in antiphase with the other elements. The line components of the rare earths appear as sharp, weak, shortward-displaced features that first wax and then wane in strength as they move longward. They reach maximum strength when their velocity equals the systemic velocity. The magnetic field of 21 Per is weak and cannot be measured with precision because of the complicated kinematic effects. The interpretation of these results in terms of a rigid-rotator model is discussed briefly. (auth)

1131 THE ANOMALOUS BEHAVIOR OF ALUMINUM OXIDE BANDS IN MIRA VARIABLES. Keenan, P. C. (Ohio State Univ., Columbus. Ohio Wesleyan Univ., Delaware); Deutsch, A. J.; Garrison, R. F. Astrophys. J., 158: 261-8(Oct. 1969).

In spectra of normal M giants, absorption bands of AlO occur with an intensity that is well correlated with the spectral type as defined by the TiO bands. In Mira variables, however, the AlO band can vary greatly from cycle to cycle and can be abnormally strong or weak for the spectral type. This behavior is not shared by other molecules, such as ScO and VO, which vary predictably with spectral type. In some Mira variables the AlO bands have been observed to go over into emission. This occurred in Mira in 1924 and 1964, R Ser in 1960, R Psc in 1966, R Crv and R Cas in 1967, and RT Lib in 1968. From a survey of all spectrograms of Mira itself available at Mount Wilson and Palomar Observatories, it was found that the AlO bands tend to be strong in absorption during "strong line" cycles and tend to be weak or reversed in "weak line" cycles. (auth)

1132 EVIDENCE OF TIDAL EFFECTS IN SOME PULSATING STARS. II. 16 LACERTAE AND β CEPHEI. Fitch, W. S. (Univ. of Arizona, Tucson). Astrophys. J., 158: 269-80(Oct. 1969).

Published observations of two β CMa stars are analyzed. The star 16 Lac is a single-line spectroscopic binary with a circular orbit of 12.096d period; the primary star pulsates in a primary

period of 0.169166d. In addition, two nonradial modes are excited, apparently by coupling to the primary pulsation through rotation and through a tidal resonance at 0.2 orbital period, respectively. The star β Cep is also found to be a single-line spectroscopic binary with an orbit of large eccentricity of 10.893d period. The orbital velocity of the primary is small because of a large primary-to-secondary mass ratio; the orbital elements are therefore rather uncertain, but they show that the primary pulsation (P_1 = 0.19049d) undergoes a strong, nonresonant amplitude modulation around the time of periastron passage, with maximum amplitude probably occurring at maximum tidal compression. A simplified theory of resonant and nonresonant tidal modulation is presented. A summary is given of presently available information relating to tidal modulations of five β CMa stars and three δ Sct stars. (auth)

1133 POPULATION INVERSIONS IN IONS OF ASTROPHYSICAL INTEREST. Smith, Howard A. (Univ. of California, Berkeley). Astrophys. J., 158: 371-83(Oct, 1969).

Simple atomic configurations are examined theoretically for possible population inversions under conditions of astrophysical interest and under the assumption of excitation by electron collisions. The rate equations for the level populations are solved by computer for ions with configurations $2p^q$ and $3p^q$ (q = 2, 3, and 4). Under a range of density and temperature conditions covering those found in planetary nebulae, these ions are found to have transitions that fall into two categories: those inverted at all low electron densities (extending up to $N_e \approx 10^{10}$ cm^{-3}); and those inverted over a short range of densities ($\Delta N_e \approx 10^3$ cm^{-3}). The gain lengths for these far-infrared transitions are calculated, and are usually found to be greater than 10^5 lt-yr; ten transitions with more favorable gain lengths (down to ~1 lt-yr) are listed. The effects of maser action on interpretations of present data are discussed, and some areas for future observations are suggested. (auth)

1134 LOWELL SUSPECT WHITE DWARFS. Greenstein, Jesse L. (Inst. for Advanced Study, Princeton, N. J. Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 158: 281-93(Oct, 1969).

A survey of eighty-six suspected white dwarfs in the Lowell GD lists shows that fifty-four are in fact, white dwarfs. These stars have a considerably smaller mean proper motion and a somewhat bluer mean color than the 202 stars observed by Eggen and Greenstein. Otherwise, the GD stars are normal white dwarfs of lower space motion than the EG sample. Line profiles, equivalent widths, and central absorptions are normal. The properties of these degenerate stars of the low-velocity population are shown in graphic form. (TSS)

1135 EFFECT OF COLLECTIVE INTERACTIONS ON THE ELECTRON-SCATTERING OPACITY OF STELLAR INTERIORS. Watson, William D. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J., 158: 303-13(Oct, 1969).

The effect of collective interactions on the electron-scattering opacity is calculated for conditions prevailing in stellar interiors. Use of the Debye–Hückel radial distribution function and neglect of collisions are shown to be adequate approximations. Collective effects decrease the electron-scattering opacity. They are important when the product of the Debye length and the photon wavenumber is near unity or smaller. The estimated influence on the total opacity in some stellar-interior regions is: (i) at the core of the Sun the opacity is reduced by approximately 10%, (ii) the opacity within the hydrogen-burning shell of low-mass red giants is decreased by 5 to 20% at many stages of evolution, and (iii) during much of the evolution, a reduction of 5 to 15% is expected in the opacity of the core and the hydrogen-burning shell of a typical horizontal-branch star. (auth)

1136 THEORY OF RADIATIVE TRANSFER IN INHOMOGENEOUS ATMOSPHERES. I. PERTURBATION METHOD. Fymat, A. L.; Abhyankar, K. D. (California Inst. of Tech., Pasadena). Astrophys. J., 158: 315-24(Oct, 1969).

If it is assumed that the albedo for single scattering $\Omega(\tau)$ differs from a constant value Ω_0 by a small amount throughout the atmosphere, the nonlinear singular integral equations for the X- and Y-functions of Chandrasekhar and the X* and Y* functions of Ueno, which describe the transfer of radiation through an inhomogeneous plane-parallel atmosphere of arbitrary stratification, are linearized by use of a perturbation technique. These equations are written in their operator form, and their iterated solutions are expressed as infinite series which, if convergent, would represent the N-solution of the problem. The convergence of the series solutions involving repeated operators is investigated, and the region of convergence is delimited for atmospheres of arbitrary optical thickness for various values of Ω_0 and s_2, the maximum fractional perturbation in $\Omega(\tau)$. This region is found to be the larger, the smaller the atmospheric thickness. (auth)

1137 THEORY OF RADIATIVE TRANSFER IN INHOMOGENEOUS ATMOSPHERES. II. APPLICATION OF THE PERTURBATION METHOD TO A SEMI-INFINITE ATMOSPHERE. Fymat, A. L.; Abhyankar, K. D. (California Inst. of Tech., Pasadena). Astrophys. J., 158: 325-35(Oct, 1969).

The nonlinear singular integral equation for the H-function of an inhomogeneous plane-parallel atmosphere of arbitrary stratification is linearized by using the perturbation method developed in Paper I. The N-solution of this equation is given. The iteration procedure for computing the fractional perturbation $h(\tau;\mu)$ in $H(\tau;\mu)$ is also described. An error analysis is performed, and the relative error in the solution, caused by the neglect of the quadratic term, is computed. Curves showing the maximum relative errors in $h(\tau;\mu)$ and $H(\tau;\mu)$ as functions of the relative perturbation, s, are presented. These curves will be useful for estimating the errors to be expected in any particular problem. For illustrating the method, H-functions for semi-infinite homogeneous atmospheres with Ω = 0.300, 0.700, 0.925, and 0.975 are computed from the H-function for an atmosphere with Ω = 0.900. (auth)

1138 PERIOD AND VELOCITY CURVE OF AE AQUARII. Payne-Gaposchkin, Cecilia (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Astrophys. J., 158: 429(Oct, 1969).

The value of K_1 for AE Aquarii is 162.5 km/sec, leading to a mass function of 0.183 $M_\odot$. If the velocities of the bright lines are used to determine the less-certain value of 145 km/sec for K_2, values of 0.59 $M_\odot$ and 0.66 $M_\odot$ are determined for $m_1 \sin^3 i$ and $m_2 \sin^3 i$. These values are smaller than those given by Joy (1954), mainly because of the shorter period. (W.D.M.)

1139 NEW SPECTRA OF THE CH MOLECULE. Herzberg, G.; Johns, J. W. C. (National Research Council of Canada, Ottawa). Astrophys. J., 158: 399-418(Oct, 1969).

Absorption spectra of CH and CD molecules have been studied in the ultraviolet and vacuum ultraviolet by means of the flash photolysis of diazomethane. The three known systems A–X, B–X, and C–X are fairly strong in absorption. Of these the last two, B–X and C–X, have been extended. In particular, in the B–X system diffuseness of the higher rotational lines has been observed. This diffuseness is a result of the predissociation previously derived from the breaking-off of the rotational structure in emission. The difference in the predissociation limits as observed in absorption and emission indicates the presence of a slight maximum in the potential function of the B $^2\Sigma^-$ state. However, it appears that sufficient tunneling at the base of the barrier arises for the predissociation limit as observed in emission to be equal to the dissociation limit, and as a result the dissociation energy of CH (and CD), now in the literature is not appreciably changed by the recognition of the potential maximum. The revised value is $D_0^\circ(CH) = 3.45_4 \pm 0.01_2$ eV. A predissociation of the C $^2\Sigma^+$ state was recognized early in this work and has already been confirmed by the lifetime measurements of Hesser and Lutz. A number of new electronic transitions have been found in the vacuum ultraviolet, including a Rydberg series starting at 1370 Å and yielding an ionization potential of 10.64 eV. At longer wavelengths new electronic transitions D $^2\Pi_i$–X $^2\Pi$, E $^2\Pi$-X $^2\Pi$, F $^2\Sigma^+$–X $^2\Pi$, and D $^2\Pi_i$–B $^2\Sigma^-$ occur at 1690, 1560, 1540, and 3007 Å. The first two and the last are clearly predissociated (diffuse) for all observed J-values, while the third is predissociated for higher J values. All vacuum-ultraviolet transitions are likely to be of importance in stellar and interstellar spectra in this spectral region. Moreover, the predissociations established in the C, D, and E states are so strong that almost every light quantum beyond 3200 Å absorbed by CH in the interstellar medium will lead to its dissociation, thus greatly limiting the lifetime of a given CH molecule. (auth)

1140 OBSERVATIONAL STUDIES RELATING TO STAR FORMATION. II. Aveni, Anthony F. (Colgate Univ., Hamilton, N. Y.); Hunter, James H, Jr. Astron. J., 74: 1021-3 (Oct. 1969).

Observational evidence is presented in support of the view that star formation may occur in small, primary condensations having masses $\lesssim$100 $M_\odot$. The small aggregate containing the T Tauri-like star BM And is discussed in some detail, and other examples are cited of similar groups of early-type stars. (auth)

1141 THE LIGHT VARIATION AND ORBITAL ELEMENTS OF AG VIRGINIS. Binnendijk, L. (Univ. of Pennsylvania, Philadelphia. Kitt Peak National Observatory, Tucson, Ariz.). Astron. J., 74: 1024-31(Oct. 1969).

New photoelectric observations of AG Virginis are presented. A total of 451 observations in yellow light, 451 in blue light, and 444 observations in ultraviolet light were made on seven nights in

1968. In all three wavelength regions there is a large difference in the heights of the maxima of the light curve, and primary minimum is permanently distorted. Secondary minimum is caused by a total eclipse. A new internally consistent set of orbital elements has been derived. (auth)

1142 THE LIGHT VARIATION AND ORBITAL ELEMENTS OF AM LEONIS. Binnendijk, L. (Univ. of Pennsylvania, Philadelphia. Kitt Peak National Observatory, Tucson, Ariz.). Astron. J., 74: 1031-7(Oct. 1969).

A total of 344 photoelectric observations in yellow light and 347 observations in blue light of AM Leonis are presented. These were obtained on five consecutive nights in March 1968. This variable is the brighter component of the visual double ADS 8024. In the present observations, the light of the fainter visual double-star component was excluded. At primary minimum the system undergoes a total eclipse. New internally consistent elements are derived. Abrami's light curve was freed from the extra light of the faint visual component by using the observed magnitude difference between the components of the visual double. This light curve can be represented by the same geometrical elements as the KPNO observations, but the photometric elements are different. A subluminous region on the larger star can be located. (auth)

1143 THE PECULIAR A-TYPE STARS. Kraft, R. P. (Univ. of California, Santa Cruz). pp 423-47 of Contemporary Physics: Trieste Symposium 1968. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.1); CONF-680629(Vol.1).

Topics covered in this review include definitions, location in the Hertzsprung–Russell diagram, rotational velocities, magnetic fields, and suggested explanations of the abundance anomalies. (auth)

1144 SHORT-PERIOD VARIABILITY OF B, A, AND F STARS. IV. VARIABILITY IN THE LOWER HERTZSPRUNG GAP. Berger, Michel (Univ. of California, Berkeley). Astrophys. J., 19: Suppl. Ser. No. 169, 99-113(Oct. 1969).

The lower instability strip extends from the main sequence upward to the RR Lyrae region. Hot and cool borders were established which intersect the main sequence at A4 and F2. In the instability strip, more than 20% of the stars show regular variability larger than 0.010 mag. These variables have normal masses and show a wide range in metal abundances and rotational velocities. Metal abundance and binary characteristics appear to have no influence on the incidence of variability. Pulsation is found to be strongly related to rotational velocity, v sin i. The variables of small amplitudes share the high rotational velocity of the nonvariables, while the incidence of larger amplitudes depends critically on low rotational velocity. The mean rotational velocity of the variables 2 magnitudes above the main sequence is less than 0.3 that of similar nonvariables. This effect decreases as the main sequence is approached. A period-luminosity-color relation is established, with an average deviation of less than 0.3 mag in M_v. The observed coefficients of log P and log $(T_e/T_{e\odot})$ agree adequately with the predicted relation $M_v = -2.5 \log P - 10 \log (T_e/T_{e\odot}) - 1.25 \log M$ + constant which assumes a variable Q value. Metal abundance and rotation have no effect on the period. The pulsation constant Q is found to vary slightly along the instability strip, and a preliminary value of $Q = 0.029 \pm 0.007$ is derived, indicating that the variables pulsate in the fundamental and/or first overtone. It is proposed that the period differences among classical Cepheids, δ Sct stars, RR Lyrae stars, and dwarf Cepheids are caused not only by luminosity differences but also by large mass differences. (auth)

1145 SHORT-PERIOD VARIABILITY OF B, A, AND F STARS. III. A SURVEY OF DELTA SCUTI VARIABLE STARS. Breger, Michel (Univ. of California, Berkeley). Astrophys. J., 19: Suppl. Ser. No. 169, 79-97(Oct. 1969).

Two hundred and thirteen bright field stars were tested photoelectrically for short-period variability. Nineteen variables and one suspected variable were found. Of these, two supergiants show irregular variability, one variable has been insufficiently studied, and the remaining variables are δ Scuti stars. The amplitude and incidence of variability depend critically on the color. The large proportion of variables with small amplitudes close to the observational limit of detection indicates that most stars inside the instability strip probably pulsate. The variables and nonvariables in the instability strip show similar galactic U, V, W velocities. Narrow-band photometric and spectroscopic data have been collected for most of the thirty-nine δ Sct variables published so far. Determinations of absolute magnitudes for these stars are discussed, and new absolute magnitudes are calculated. Data on all stars inside the instability strip considered to be either variable or nonvariable have been collected, and a further list of suspected variables is given. (auth)

1146 EXPECTED FRACTION OF EVOLVED CLOSE BINARIES AMONG MAIN-SEQUENCE STARS OF SPECTRAL TYPE EARLIER THAN A5. van den Heuvel, E. P. J. (Univ. of California, Santa Cruz). Astron. J., 74: 1095-1101(Nov. 1969).

The expected fraction of close-binary remnants (CBR) among main-sequence stars of spectral type earlier than A5 is computed under the assumption of a constant stellar formation rate. A CBR is defined as the remaining main-sequence component of a binary that evolved with mass exchange. Only systems in which the mass exchange occurs shortly after core-hydrogen exhaustion of the primary are considered. The expected fraction of CBR is shown to vary between about 1.2 times (for $f = 0$) and 0.15 times (for $f = 1$) the fraction of unevolved close binaries in case B, where f is the fraction of the exchanged matter which is lost from the systems. For $f \leq 0.3$ (as roughly indicated by observations of semidetached systems) at least 11.7% (and possibly up to 22%) of the main-sequence stars earlier than A5 are expected to be CBR. After due allowance for inclination effects, only about 2.5% of the stars in this spectral range are observed to be semidetached systems. Other possible identifications of CBR are briefly discussed. (auth)

1147 SPECTROSCOPIC INVESTIGATION OF VISUAL BINARIES WITH B-TYPE PRIMARIES. Murphy, Robert E. (Case Western Reserve Univ., Cleveland. Kitt Peak National Observatory, Tucson, Ariz.). Astron. J., 74: 1082-94(Nov. 1969).

The absolute magnitudes of B stars were investigated using visual binaries with B-type primaries. A new calibration is presented for the main-sequence stars of types B0.5–B9 and new data on the absolute magnitudes of several classes of giants and supergiants are presented. The new main-sequence calibration was obtained independently of galactic structure considerations and it is independent of previous calibrations using open clusters. The new main sequence is systematically fainter than that of Johnson and Iriarte (1958) but brighter than those of Weaver and Ebert (1964) and FitzGerald (1969). Four of the secondaries are peculiar A stars. Their presence in systems with main-sequence B stars implies that they are young objects. These four stars represent 10% of the secondaries between B9 and A7, the same percentage as is found for single field stars. At least 17 of the main-sequence B-type primaries have secondaries which appear to be contracting towards the main sequence. Only three of these stars are in galactic clusters, the other being in the general field. Seven of the contracting secondaries are in the Hertzsprung gap, eight others have anomalously strong hydrogen lines for their types (F0 and later) and two have H and K in emission. (auth)

1148 PHOTOELECTRIC LIGHT ELEMENTS FOR THE ECLIPSING BINARY AB ANDROMEDAE. Landolt, Arlo U. (Louisiana State Univ., Baton Rouge. Kitt Peak National Observatory, Tucson, Ariz.). Astron. J., 74: 1078-82(Nov. 1969).

New times of minima derived from UBV photoelectric observations of AB Andromedae around the time of minimum light are presented. (auth)

1149 INTERSTELLAR EXTINCTION ANOMALIES AND THE DIFFUSE INTERSTELLAR BANDS. Walker, G. A. H. (Univ. of British Columbia, Vancouver); Hutchings, J. B.; Younger, P. F. Astron. J., 47: 1061-6(Nov. 1969).

Interstellar extinction curves (Δm_λ vs $1/\lambda$) of 20-Å resolution were obtained from photoelectric scanner observations in the range λλ4000 to 5000 for the five stars HD 37022, 46711, 183143, 198478, and 211971, and of 50-Å resolution for the stars HD 154043, 154368, 160529, 167971, in the range λλ4000 to 5600 from photoelectric data published by Willstrop. Apart from a closely linear portion between λλ5800 and 4900, the curves show significant irregularities, many of which appear to be associated with the diffuse interstellar bands. In particular, there are changes of gradient or discontinuities associated with the broadest diffuse interstellar bands at λλ6180, 4882, 4761, and 4430. There is a marked discontinuity near λ5800 and for some stars a broad absorption band near λ4200. The λ4430 band lies between two unequal wings of anomalously low extinction (one of which has been detected at Edinburgh). The irregularities vary from star to star and seem to be analogous to the irregularities in the available rocket ultraviolet observations of the extinction curve, and bear a close resemblence to certain laboratory absorption spectra of solid hydrocarbon mixtures recently reported. (auth)

1150 EFFECTS OF HYPERONS ON THE VIBRATIONS OF NEUTRON STARS. Lange, William D. (Goddard Space Flight Center, New York. Yale Univ., New Haven); Cameron, A. G. W. Astrophys. Space Sci., 5: 213-53(Oct. 1969).

The effects of hyperons and resonance particles on the vibra-

tions of neutron stars are calculated. Vibrating neutron stars can store large amounts of energy in their vibrations; the interaction of the vibrations with the atmosphere would produce electromagnetic radiation. If any process damps out the vibrations rapidly on an astronomical time scale (~1000 years) then vibrating neutron stars are not likely to be found. Previous work indicates that radiation by a neutrino URCA process ($N + N \rightarrow P + N + e^- + \bar{\nu}_e$) does not rapidly damp many of the neutron star models. Some neutron stars are predicted to contain massive baryons; thermal damping by nonequilibrium reactions involving these baryons is studied. During vibrations the thermodynamic equilibrium state is changed and particle reactions attempt to restore equilibrium. If the reaction rates per particle are very rapid or slow compared to the frequency of vibration the system follows almost the same pressure–volume curve through both parts of the gas cycle, and very little work is done. In the intermediate case, when reaction rates are comparable to the frequency, damping is rapid. It is found that the reaction rates for weak interactions such as $N + N \rightarrow P + \Sigma^-$ (the Σ^- is the first hyperon to appear with increasing density in degenerate neutron star matter) are of the right magnitude to cause rapid damping. If there is a hyperon region in the star then it cannot sustain vibrations. The much faster (and hence less important) process $N + N \rightarrow P + \Delta^-$ is also considered. (auth)

1151 THERMAL GENERATION OF MAGNETIC FIELDS WITH RADIATION PRESSURE IN ROTATING STARS. Kato, Shoji; Nakagawa, Y. (National Center for Atmospheric Research, Boulder, Colo.). Astrophys. Space Sci., 5: 171-9(Oct. 1969).

It has been suggested by Biermann that in rotating stars the electron partial pressure could generate a toroidal magnetic field of a considerable strength. However, Mestel and Roxburgh have shown recently that the generation of such a toroidal magnetic field could almost completely be suppressed when a weak primordial poloidal magnetic field exists in the star. In this paper, it is shown that a toroidal magnetic field of a moderate strength could be generated even in the presence of a poloidal magnetic field, if the effect of radiation pressure is taken into consideration. This considered mechanism is effective for moderately massive stars, and numerical estimate indicates that in A type stars a toroidal magnetic field of the order of a thousand gauss can be generated near the surface within the time scale of the evolution of the star. (auth)

1152 NUCLEOSYNTHESIS IN NEUTRON STAR ATMOSPHERES. Rosen, Leonard C. (Yeshiva Univ., New York). Astrophys. Space Sci., 5: 150-70(Oct. 1969).

The composition of neutron star atmospheres is calculated as a function of time including effects of diffusion, cooling, and thermonuclear reactions. A seven-component nuclear reaction network which includes ^{4}He, ^{12}C, ^{16}O, ^{20}Ne, ^{24}Mg, ^{28}Si, and ^{56}Fe is utilized. Neutron star models with different initial nuclear abundances are compared as to subsequent nucleosynthesis. It is found that the final abundances are independent of original composition assuming ^{4}He as the major initial constituent. The final composition of the atmosphere is predominantly ^{56}Fe. Mass loss from an evolving neutron star is examined as a possible source of cosmic rays. It is found that a neutron star contributes only ^{56}Fe significantly to the cosmic-ray spectrum. (auth)

1153 POSSIBLE MODEL OF SUPERNOVAE: DETONATION OF ^{12}C. Arnett, W. David (California Inst. of Tech., Pasadena. Inst. of Theoretical Astronomy, Cambridge, Eng.). Astrophys. Space Sci., 5: 180-212(Oct. 1969).

Stars of intermediate mass ($4M_\odot \lesssim M \lesssim 9M_\odot$) may ignite the $^{12}C + ^{12}C$ reaction explosively because of the high degree of electron degeneracy in their central regions. After the exhaustion of helium burning in the core of such stars, a helium-burning shell develops which is thermally unstable. Approximating this shell by suitable boundary conditions, the subsequent evolution of the core is examined quantitatively by standard techniques. An explosive instability due to ignition and detonation of $^{12}C + ^{12}C$ develops at a central density $\rho_c \sim 2 \times 10^9$ g/cm^3. Subsequent hydrodynamic expansion is computed; final velocities of expansion up to $v \sim$ 20,000 km/sec are found. The star is totally disrupted; no condensed remnant is left. Such an explosion may be a plausible model for a significant fraction of supernovae. Investigation of the relevant nuclear reaction network shows that the entire core ($M_{core} \sim 1.37M_\odot$) is processed through ^{12}C burning, ^{16}O burning, and silicon burning. Significant amounts of ^{56}Ni are produced. This nucleosynthesis is critically sensitive to the exact central density at which the $^{12}C + ^{12}C$ reaction ignites; several factors which affect this critical density are discussed. A brief summary of other supernovae theories which have been expounded in detail is presented for comparison. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

1154 EVIDENCE FOR A POINT SOURCE OF HIGH-ENERGY COSMIC GAMMA RAYS. Frye, G. M. (Case Western Reserve Univ., Cleveland); Staib, J. A.; Zych, A. D.; Hopper, V. D.; Rawlinson, W. R.; Thomas, J. A. Nature (London), 223: 1320-1(Sept. 27, 1969).

Two high-altitude balloon flights from Parkes, NSW, produced evidence for a point source of high-energy gamma rays (above 50 MeV) from a point source in Sagittarius. The flights did not confirm the band source of gamma rays reported by Clark, Garmire, and Kraushaar (Astrophys. J. Lett., 153: L203(1968)). (auth) (UK)

1155 QUASI-STELLAR OBJECTS: A PROGRESS REPORT. Burbidge, G. R.; Burbidge, E. M. (Univ. of California, San Diego. Univ. of Cambridge, Eng.). Nature (London), 224: 21-4(Oct. 4, 1969).

A review of the present status of studies on QSO's is given under the following headings: Historical and introductory; variability; distribution in the sky; absorption and emission redshifts; physical models; and redshifts and cosmology. (UK)

1156 PULSAR PP 0943. Vitkevich, V. V.; Alekseev, Yu. I.; Zhuraviev, V. F.; Shitov, Yu. P. (Lebedev Inst. of Phys-Physics, Moscow). Nature (London), 224: 49(Oct. 4, 1969).

During investigation of pulsars in the metre-wavelength range at the radio astronomy station in Pushchino, using the E–W arm of the cross radio telescope DCR-1000, a new pulsar was detected on Dec. 2, 1968, at frequencies of 89.6 and 90.4 MHz. Further observations of this pulsar, designated PP 0943, were also made at frequencies of 70 and 80 MHz. The intensity varied within wide limits, and there was a considerable change between adjacent pulses. The strongest pulses showed intensities of 70 to 270×10^{-26} Wm^2 H$_z^{-1}$ at 70 MHz, with a bandwidth of 80 kHz. The position of PP 0943 is R.A. 9h 43m 15s ± 30s and decl. 8° ± 4°. The period was measured as P = 1.093 ± 0.003s. The frequency dispersion is 3.7 MHz S^{-1} at 81.5 MHz, corresponding to an integrated electron density of 17.5 cm^{-3} pc along the line of sight, and the pulse duration about 60 ms at 70 MHz. The pulses showed a complex structure, and fine structure was observed in the spectrum. (UK)

1157 BREMSSTRAHLUNG RADIATION IN INTENSE MAGNETIC FIELDS. Simon, M.; Strange, D. L. P. (California Inst. of Tech., Pasadena). Nature (London), 224: 49-50 (Oct. 4, 1969).

It is considered that the very high surface brightness temperatures of pulsars at radio frequencies imply that the radiation at these frequencies must be produced by some type of coherent emission mechanism, and it was proposed (Chiu and Canuto, Phys. Rev. Lett., 22: 415(1969)) that such emission may be due to a modified bremsstrahlung mechanism taking place in the very strong magnetic fields expected to be associated with neutron stars. It was argued that oscillations of the neutron star may cause a population inversion of the radiating electrons and thus possibly give rise to coherent radiation. The present communication points out that such a modified bremsstrahlung mechanism cannot, for any electron distribution, lead to coherent radiation. (UK)

1158 HARD X RAYS FROM THE CRAB PULSAR. Floyd, F. W.; Glass, I. S.; Schnopper, H. W. (Massachusetts Inst. of Tech., Cambridge). Nature (London), 224: 50-1(Oct. 4, 1969).

Measurements are reported on the pulsed emission of high energy x rays from the Crab Nebula pulsar NP 0532. The measurements covered photon energies of 25 to 100 keV and were made with a balloon-borne x-ray telescope launched from Palestine, Texas, on May 10, 1969. The measurement technique employed is described in detail, and histograms of the data obtained are reproduced. The distribution of pulse arrival times was similar to that for soft x rays in that there were two peaks, the second being wider and having a leading edge appearing to commence at the end of the first peak. The separation of the peaks was 14 ± 1 ms as compared with 13.3 ± 0.3 ms for soft x rays and 13.55 ms optical, and the intensity ratio of the second peak to the first was 1.7:1 as compared with 1:1 for soft x rays and 0.6:1 visible light. There thus appeared to be a steady trend towards greater relative output in the second pulse at higher quantum energies. The pulsed component represented 15 ± 5% of the total Crab output in the 25- to 100-keV range. (UK)

1159 SUDDEN CHANGES IN THE INTENSITY OF HIGH-ENERGY X RAYS FROM SCO X-1. Agrawal, P. C.; Biswas, S.; Gokhale, G. S.; Iyengar, V. S.; Kunte, P. K.; Manchanda, R. K.; Spreekantan, B. V. (Tata Inst. of Fundamental Research, Bombay). Nature (London), 224: 51-3(Oct. 4, 1969).

The observation of sudden changes in the x-ray intensity of Sco X-1 by a factor of about three in the energy interval 29.9 to 52.3 keV on Dec. 22, 1968 is reported and discussed. This observation was made with an x-ray telescope in a balloon flight from Hyderabad, and details of the technique employed are given. A ^{241}Am source was employed to provide in-flight calibration of the detector. A plot is shown of the observed intensity of Sco X-1 in the above energy interval as a function of time, and it is indicated that the intensity at first decreased by a factor of about three, remained constant for a time, and then again suddenly increased by a factor of three before decreasing again; the rise and fall occurred in times less than about 15 min, giving rise to what may be called a flare. It was clear that there is considerable spread in the flux values of Sco X-1 recorded by different observers at different times. (UK)

1160 OBSERVATIONS OF SHELL-TYPE GALACTIC RADIO SOURCES. **Hill, E. R. (CSIRO, Sydney). Proc. Astron. Soc. Aust., 1: 21(Jan. 1967).**

Observations were made with the Parkes radiotelescope of 4 galactic radio sources having either a nonthermal radio spectrum, or exhibiting shell structure in their emitting regions. Observations were made at a wavelength of 11 cm where the beamwidth is about 7.5 min arc. The catalog numbers of the sources are, using the Parkes nomenclature, 1439−62 (a previously known supernova remnant), 0902-38, 1544-55, and 0629 + 04 (the Rosette Nebula). The sources 0902-38 and 1544-55 have a nonthermal radio spectrum and are therefore presumed to be supernova remnants. Their positions at epoch 1950.0, fluxes at 20 cm, and flux spectral indices are given. Attempts were made to deduce from the contour maps of 0629 + 04, 0902-38, and 1439-62, models of the volume emissivity within them. It was found that the emitting regions of 0629 + 04 and 0902-38 are very thick shells; in 0629 + 04 there is a definite tendency for the volume emissivity to concentrate towards the inner surface of the shell. No spherically symmetrical model would fit the source 1439-62. (BBB)

1161 A SUPERNOVA REMNANT IN CENTAURUS. **Whiteoak, J. B.; Gardner, F. F. (CSIRO, Sydney). Proc. Astron. Soc. Aust., 1: 22-3(Jan. 1967).**

Observations of the composite radio source which includes the cataloged components 1209-52 and 1209-51 were obtained at frequencies 629, 1410, and 2650 MHz with the 210-ft Parkes telescope. Isophotes at the highest frequency are shown. The distribution of radiation resembles the shell-like appearance of radio emission associated with Type-II supernova remnants, although its peak brightness temperatures are more than three orders of magnitude lower than those of Cassiopeia A. Distance estimates were 350 and 2200 parsec. Confinement of the source to within 200 parsec of the galactic plane yields a maximum distance and diameter of 1100 and 40 parsec. The integrated flux density is sufficiently low to be accountable by either of the models of van der Laan, in which the radiation emanates from the compressed interstellar field between the shock wave and the expanding shell. Interpretations suggest that the interstellar field must have a component, transverse to the line of sight, which is aligned perpendicular to the galactic plane. The distribution of radiation for the supernova 1006 A.D., 30° away in galactic longitude, indicates a similar conclusion. In contrast, a similar interpretation for Cassiopeia yields a field component parallel to the galactic plane. An anisotropic explosion and morphology similar to that used to explain extragalactic sources are suggested. The field observed is that accompanying the plasma. If one of the source components is located at the rear of the expanding shell, then the opposite senses of the rotation measures for the two components might be explained in terms of internal Faraday rotation. (BBB)

1162 OPTICAL OBSERVATIONS OF EXTRAGALACTIC RADIO SOURCES. **Westerlund, B. E.; Wall, J. V.; Stokes, N. R. (Australian National Univ., Canberra). Proc. Astron. Soc. Aust., 1: 23(Jan. 1967).**

Photometric observations on the UBV system were made of some optically identified radio sources. The measurements were based on: (1) offset photometry with the Siding Spring 40-in. reflector of objects identified as probable quasars or N galaxies, and (2) observations with the Siding Spring 24-in. reflector of radio galaxies brighter than V = 14.0^m. For six relatively bright radio galaxies, radial velocities were determined. The mean visual absolute magnitude (with H = 100 km/sec/Mpc) is $-21^m.2 \pm 0^m.2$ (p.e.). It was concluded that the greater activity which must be present in a radio galaxy does not show up as an anomaly in the integrated colors when these colors are measured over the entire galaxy. However, measurements with a series of apertures may reveal anomalous colors for the region in which the radio emission is produced. (BBB)

1163 RADIO OBSERVATIONS OF CLUSTERS OF GALAXIES. **Mills, B. Y.; Shobbrook, R. R. (Univ. of Sydney). Proc. Astron. Soc. Aust., 1: 24(Jan. 1967).**

An examination of radio sources and their identification with actual galaxies or other objects are presented. Observations were made on selected groups of clusters in the Abell catalog, using the E−W arm of the Molonglo cross-type radio telescope and the Arecibo 1000-ft reflector. Of the sixteen sources detected, it was possible to suggest reasonable identifications for fifteen; the position of the unidentified source occurring in a field empty of galaxies or blue stellar objects. One of the fifteen possible identifications appears to be a quasar and is sufficiently distant from the cluster (A869) to assume that it is not related; the remainder appear to be galaxies. Five of these fourteen suggested galaxy identifications had previously been known. About eight or ten of the twenty clusters studied appear to contain clearly identified radio galaxies. (BBB)

1164 ACCURATE POSITIONS OF EXTRAGALACTIC RADIO SOURCES. **Shimmins, A. J. (CSIRO, Sydney). Proc. Astron. Soc. Aust., 1: 24-5(Jan. 1967).**

By use of the Parkes Telescope, accurate positions of over 700 extragalactic radio sources were obtained for optical identification of the sources. All sources with flux density greater than 1.8 f.u. at 20 cm (1 f.u. at 11 cm) were positioned (this corresponds to ~85 sources per steradian) together with some weaker sources in the northern areas. Over 500 sources were positioned in the zone +27° to −33°, which is covered by the Palomar Sky Survey. With the positional accuracy given, ~60% of the sources were identified with optical objects, and most unidentified sources are objects beyond the limit of the Palomar Sky Survey; i.e., greater positional accuracy might not improve greatly the percentage of identifications. In addition to accurate positions, a uniform set of flux densities was obtained. (BBB)

1165 ANGULAR SIZES OF RADIO SOURCES. **Ekers, R. (Australian National Univ., Canberra). Proc. Astron. Soc. Aust., 1: 25-6(Jan. 1967).**

Observations of 140 radio sources were made with the 210-ft (60-ft variable baseline) interferometer at the Australian National Radio Astronomy Observatory. Forty-seven were sufficiently well resolved (>1.3′ arc) to determine structural details. The resolved sources could be separated into well-defined classes; simple sources (2), core−halo sources (8), double sources (31), and more complex sources (6). For these well-resolved sources for which optical information is available, all except three have been identified with galaxies. Four of the core−halo sources were identified with bright galaxies, the spirals NGC 253, 495, and 5236 and the elliptical NGC 2663. In each case the core is barely resolved (~0.6′ arc) and the halo is approximately coextensive with the optical object. Other core−halo sources, and the single, double, and more complex sources were all identified with fainter, type-E or -D galaxies and are intrinsically more powerful radio emitters. In most models proposed to explain double radio sources, the radio source is produced in the center of the galaxy and expands outwards. A search was made for correlations between some parameters of double sources that might be expected to show evolutionary effects, viz., linear separation, absolute power, spectral index, brightness temperature, and intrinsic polarization angle. No significant correlation was found between any of these, and the previously found weak correlations in the northern data have not been supported. (BBB)

1166 TIME VARIATIONS OF THE SPECTRUM OF 3C279. **Harris, Beverley J. (Australian National Univ., Canberra). Proc. Astron. Soc. Aust., 1: 26-7(Jan. 1967).**

The spectrum of the radio source 3C 279 (1253-05) in mid-1966 derived from observations at frequencies of 467, 630, 960, 1410, 2650, and 5000 MHz is shown. Above 2650 MHz the flux density is decreased, whereas below this frequency it is increased at least down to 960 MHz. This is consistent with earlier results. At a frequency of 2650 MHz, no variation greater than a few percent was seen. The spectrum over the observed frequency range was considered as the superposition of two spectra: a constant one which dominates at the lower frequencies, with a spectral index of −0.6, and a high-frequency component which is time-variable. This high-frequency radiation may be synchrotron emission from an expanding source which is optically thick at lower frequencies. In the optically thick case the increasing angular size causes the flux to increase, and the decreasing magnetic field increases the emission at a given frequency. At higher frequencies where the source becomes optically thin, the decreasing magnetic field and electron energies reduce the flux at a given frequency. (BBB)

1167 ELLIPTIC POLARIZATION OF SYNCHROTRON RADIATION. **Legg, M. P. C.; Westfold, K. C. (Monash Univ., Melbourne). Proc. Astron. Soc. Aust., 1: 27-8(Jan. 1967).**

The Stokes parameters were calculated for the emission from a distribution of electrons by including the next approximation to their values for a single electron as well as the asymmetric distribution with respect to the angular distance ψ, for the case of monoenergetic electrons and for a power-law energy distribution. (BBB)

1168 X-RAY SURVEYS OF THE QUIET SUN, THE MAGELLANIC CLOUDS, AND THE CYGNUS REGION. Edwards, P. J.; McCracken, K. G. (Univ. of Adelaide). Proc. Astron. Soc. Aust., 1: 28-9(Jan. 1967).

Balloon-borne alt-azimuth mounted x-ray telescopes detected hard x rays ($h\nu > 20$ keV) from discrete sources in the Cygnus region. Data from the northern hemisphere flights indicated an x-ray source in the region of Cygnus A and Cygnus XR1. Examination of spectral and positional information showed the flux from the direction of Cyg A to be significantly harder than that from the direction of Cyg XR1. Furthermore, the azimuthal intensity profile was appreciably wider than for a single point source, a result consistent with the detection of 2 separate sources. After correction for atmospheric absorption and telescope geometry, the photon flux ($E > 30$ keV) was found to be 55 ± 15% higher than that measured 6 months earlier in April. The flux measured in a third flight in June 1966 was not significantly different from that in the April flight. These results provide further evidence for a time variation in the intensity of the Cygnus composite source. If the radiation is of synchrotron origin such variation may reflect fluctuations in the acceleration processes since the lifetime of 10^{13} eV electrons in a 10^{-2} gauss field is only of the order of days. Upper limits to the hard x-ray flux from a number of celestial objects were also obtained. (BBB)

1169 COSMIC RAY ASTRONOMY AT HOBART. Jacklyn, R. M. (Univ. of Tasmania, Hobart, Australia). Proc. Astron. Soc. Aust., 1: 29(Jan. 1967).

Studies to locate sources of galactic x rays in a part of the southern sky inaccessible from the northern hemisphere are described, as well as evidence for intensity maxima from fixed galactic directions in the otherwise isotropic charged primary radiation. Annual average sidereal daily variations observed with Geiger counter telescopes at depths from 30 to 60 mwe underground gave evidence for small intensity maxima, outside the Earth's field region, in both directions along an axis whose coordinates in the southward direction are estimated to be RA = 0700 ± 0100, Dec = −36° ± 5°. It is therefore concluded that the anisotropy originates in the local galactic magnetic field whose direction deduced from the cosmic-ray observations is in accord with radio and optical determinations. (BBB)

1170 DIGITAL MEASUREMENT OF RADIO SOURCE POSITIONS. Large, M. I.; Murdoch, H. S. (Univ. of Sydney). Proc. Astron. Soc. Aust., 1: 32-3(Jan. 1967).

Methods that are appropriate for determining radio source positions directly from sampled data are discussed. The techniques were developed using the digitally recorded data from a source survey carried out with the east–west arm of the Molonglo Telescope in April 1966. The techniques were applied to the measurement of the position of 2 radio sources 3C 237 and 3C 444 each of which was observed on about 40 separate days during the survey. The results of these 2 sources, which are absolute position measurements based on aerial collimation errors determined by independent means are shown together with results from other observers. The use of the three simultaneous fan beams in the survey provided an unusual opportunity to analyze the position error in the measurements. The technique was tested on weak sources. At a flux density ≲3 f.u. the position errors became increasingly dominated by thermal noise, which was inversely proportional to the source amplitude. Both the magnitude of this effect and its amplitude dependence were correctly predicted by the theory of the lease squares fitting process. (BBB)

1171 ABSOLUTE LUMINOSITY AND COLOR FOR 29 QUASARS. Abramowicz, M. Postepy Astron., 17: 281-5(Sept. 1969). (In Polish).

Formulas are developed for the absolute luminosities of quasars as observed by various observatories. Tabular data are given for twenty-nine quasars divided into nine groups. (R.V.J.)

1172 PULSARS. Grzedzielski, Stanislaw. Postepy Astron., 17: 179-99(Sept. 1969). (In Polish).

The observational data on pulsars and their theoretical interpretation, as published during the first year after the announcement of the discovery, are reviewed. (auth)

1173 CALCULATED TRANSITION ARRAY FOR THE CONFIGURATIONS $3d^2$–3d4p IN Ti III. Mendlowitz, H. (Howard Univ., Washington, D. C. National Bureau of Standards, Washington, D. C.). Astrophys. J., 158: 385-8(Oct. 1969).

Line strengths were calculated in intermediate coupling for transitions between the configurations $3d^2$ and 3d4p in Ti III. The results support the conclusion by Bahcall and others that an earlier identification of Ti III in the quasi-stellar object PKS 0237-23 must be rejected. (auth)

1174 A SURVEY FOR GALACTIC OH EMISSION SOURCES. Turner, B. E. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astron. J., 74: 985-93(Oct. 1969).

A search for anomalous OH emission was made in 87 galactic regions which comprise mainly three categories: (a) highly reddened stellar associations and clusters considered by Reddish (1967) to be regions of star formation; (b) Wolf–Rayet stars associated with nebulosity; (c) galactic emission nebulae. OH emission or absorption was mapped in the previously known sources W41 and W42, and detected in the peculiar object K3–50. The absence of OH emission in all other cases is discussed in terms of the nature of the sources, as far as is known. (auth)

1175 DISTRIBUTION OF BRIGHTNESS IN POLARIZATION OF TAURUS A AND BRIGHTNESS DISTRIBUTION OF NGC 1976 AT 9.55-MM WAVELENGTH. Johnston, K. J.; Hobbs, R. W. (Naval Research Lab., Washington, D. C.). Astrophys. J., 158: 145-50(Oct. 1969).

The polarized brightness distributions of Tau A and NGC 1976 were determined at a wavelength of 9.55 mm using a 1.6′ beam Flux densities of 313 ± 50 and 253 ± 37 f.u. were found for Tau A and NGC 1976, respectively, relative to Jupiter. (auth)

1176 HEATING OF H I REGIONS BY SOFT X RAYS. Silk, Joseph; Werner, Michael W. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Astrophys. J., 158: 185-92(Oct. 1969).

Recent observations of diffuse soft x rays at 0.25 keV indicate that the energy input to H I regions due to photoionizations by soft x rays and collisional ionizations by photoelectrons may be comparable in importance to cosmic-ray heating. Possible extrapolations of the flux of soft x rays below 0.25 keV are considered, and some differences between heating by soft x rays and heating by cosmic rays are discussed. (auth)

1177 HEATING OF H I REGIONS BY ENERGETIC PARTICLES. II. INTERACTION BETWEEN SECONDARIES AND THERMAL ELECTRONS. Spitzer, Lyman Jr.; Scott, Eugene H. (Princeton Univ. Observatory, N. J.). Astrophys. J., 158: 161-71(Oct. 1969).

Direct heating of the thermal electrons by cosmic-ray primaries and secondaries is taken into account in the computation of the electron densities and temperatures in H I regions. The mean kinetic energy $\langle E_h \rangle$ available for heating the gas per free electron produced increases from 3.4 eV for low $n_e/n(H\ I)$ to 31 eV for n_e about equal to n(H I). When n_e/n_H exceeds about 0.1, heating of the thermal electrons by the primary energetic particles becomes the dominant source of thermal energy for the gas. If the cosmic-ray flux at low energies is assumed to be no greater than that observed near the Earth, the computed temperature and density are about the same as were found in Paper I, in which direct heating of the thermal electrons was ignored. If the heating by cosmic rays is given a maximum value computed from the observed energy released in Type I supernova shells, the temperature at low hydrogen densities is much increased, with about 10,000° found for n_H equal to 0.1 cm^{-3}, and somewhat higher values at lower n_H. The value of n_e in this case varies very slowly with n_H, increasing from 0.01 to 0.02 cm^{-3} as n_H increases from 3×10^{-2} to 3 cm^{-3}. The pressure is a maximum for n_H about equal to 0.3 cm^{-3}, and the medium will be thermally unstable for somewhat lower values of n_H. These results are consistent with the familiar but unproved hypothesis that the rarefied medium between clouds is in pressure equilibrium with the denser gas within the clouds; thus a gas with $n_H = 0.03$ cm^{-3} and T about equal to 10,000°K could be in pressure equilibrium with a dense gas, with $n_H = 10$ cm^{-3} and T equal to about 30°K. (auth)

1178 RESULTS OF GAMMA-RAY BALLOON ASTRONOMY. Fichtel, C. E.; Kniffen, D. A.; Oegelman, H. B. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J., 158: 193-206(Oct. 1969).

The results obtained from recent high-altitude balloon flights of the Goddard γ-ray telescope with a digitized spark chamber are reported and combined with earlier work. The data on the region near the galactic center are reanalyzed in terms of a possible line source in the galactic plane. The analysis leads to a value of $(2.3 \pm 1.2) \times 10^{-4}$ γ (cm^2 sec rad)$^{-1}$ above 100 MeV for a galactic-latitude interval of −3° to +3° in the region near the galactic center; this result in itself does not justify the claim of a de-

tected flux, but it is consistent with the line intensity of $(4.1 \pm 0.7) \times 10^{-4}$ γ $(cm^2 \text{ sec rad})^{-1}$ quoted from recent OSO-III results. The flux and energy spectrum of the atmospheric background were measured as a function of angle with respect to the vertical. The measured downward flux is in reasonable agreement with measurements of other experimenters at several energies; however, the upward flux for energies above 100 MeV is a factor of about three lower than that measured in the OSO-III experiment mentioned above. This difference seems larger than would be expected, but small compared with the difference between the galactic γ-ray flux observed by OSO-III and the predicted one. The upper limits to possible point sources of γ-rays are summarized and are shown generally to fall above the fluxes expected from a straight extrapolation of the x-ray spectra. No positive evidence for a point source has been found. (auth)

1179 HIGH-ENERGY X RAYS FROM CYGNUS XR-1. Bingham, R. Graham; Clark, Christopher D. (Boeing Co., Seattle). Astrophys. J., 158: 207-18(Oct, 1969).

Celestial x rays (20 to 130 keV) from Cyg XR-1 were detected during a high-altitude balloon flight on 1967 May 3 from Palestine, Texas. The measured photon flux in the energy range 20.0 to 30.9 keV corrected to the top of the atmosphere is 0.0200 ± 0.0031 photons cm^{-2} sec^{-1} keV^{-1} which confirms a recently reported high x-ray intensity from Cyg XR-1 during May 1967. Results are consistent with a continuum energy spectrum given by $60.0E^{-2.50(+0.60,-0.50)}$ photons cm^{-2} sec^{-1} keV^{-1}. It is found moreover, that the present measurements are equally compatible with either a blackbody at 1.2×10^{8}°K or a hot, thin plasma at 3.5×10^{8}°K. Comparison of the measurements with observations of other experimenters covering a broader range of energy indicates that the spectrum of Cyg XR-1 is probably not just a simple power-law or exponential function; however, a blackbody curve can be excluded. Evidence is presented which demonstrates significant variations in intensity at ~30 keV of Cyg XR-1 over time intervals of a week or more, although no periodic component stands out. (auth)

1180 POLARIZATION OF THERMAL X-RAY SOURCES. Angel, J. R. P. (Columbia Univ., N. Y.). Astrophys. J., 158: 219-24(Oct, 1969).

It is shown that radiation from thermal x-ray sources which are not spherically symmetric may show polarization of the order of 1 to 5% due to Thomson scattering. (auth)

1181 HELIUM ABUNDANCES AND THE SIZES OF He II AND H II REGIONS. Rubin, Robert H. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astron. J., 74: 994-8(Oct, 1969).

The relative sizes of the ionized helium and ionized hydrogen regions in gaseous nebulae were examined using current model atmospheres for early-type stars. The problem was handled in a general context, and it was found that within an extremely narrow range of stellar effective temperatures, the ratio of the He II to H II volumes changes from nearly zero to one. How this affects the determination of the relative abundances of helium and hydrogen in diffuse nebulae is considered. Comparisons with existing observations of adjacent helium and hydrogen radio recombination lines indicate good agreement with theory. Additional observational tests are suggested—including a test for whether the Orion Nebula is ionization bounded. (auth)

1182 ON THE DISTANCE TO SCORPIO XR-1. Wallerstein, George (Univ. of Washington, Seattle). Astron. J., 74: 999(Oct. 1969).

The published proper-motion data and the spectroscopic data from interstellar K-line strengths do not support the conclusion that Sco XR-1 is physically associated with the Sco–Cen association. (auth)

1183 SEARCH FOR SEISMIC SIGNALS AT PULSAR FREQUENCIES. Wiggins, Ralph A.; Press, Frank (Massachusetts Inst. of Tech., Cambridge). J. Geophys. Res., 74: 5351-2(Oct. 15, 1969).

Dyson (1969) concluded that the seismic signals expected from plausible models of pulsars are too small by a factor of 10^5 to be detectable in the presence of naturally occurring seismic noise. He pointed out, however, that the uncertainties are so great that an attempt to detect pulsars seismically is warranted. An effort was made to detect seismic signals at pulsar frequencies by means of the 525-element LASA in Montana. The only conclusion arrived at was that if ground motion is excited by gravitational waves from the pulsars studied, then the amplitudes are smaller than about 0.01 mμ. (W.D.M.)

1184 A THEORETICAL MODEL OF PULSATING NEUTRON STARS (PULSARS). Kumar, N. (Univ. of British Columbia, Vancouver). Phys. Lett., 30A: 199-201(Oct. 6, 1969).

Angular momentum and moment-of-inertia considerations peculiar to heavy nuclei when applied to neutron stars predict a highly elongated ellipsoidal object, spinning about a minor axis. Preferential emission off the major axis ends may account for the observed pulsations. (auth)

1185 DISCRETE EXTRASOLAR X-RAY SOURCES. Rossi, B. B. (Massachusetts Inst. of Tech., Cambridge). pp 371-91 of Contemporary Physics: Trieste Symposium 1968. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.1); CONF-680629(Vol.1).

Consideration of atmospheric absorption, cosmic-ray background, and flux density of radiation from celestial sources shows that the observation of (1) soft x rays, (2) hard x rays, and (3) γ rays requires the use, respectively, of (1) rockets or satellites, (2) balloons or satellites, and (3) satellites. Discrete sources have been observed only in the spectral regions of soft and hard x rays. The most likely processes responsible for the x ray emission from these sources are thermal radiation from a hot plasma cloud and synchrotron radiation by relativistic electrons. About 30 discrete x-ray sources are known. They cluster round the galactic equator; hence most of them must be galactic objects. Some of the galactic x-ray sources have been identified with supernova remnants, others with peculiar point-like optical objects. These two groups of x-ray sources exhibit characteristic differences with regard to angular diameter, variability, and spectrum. A few sources at high galactic latitude have been detected. These are likely to be extragalactic objects; one of them has been tentatively identified with the radio galaxy M-87. (auth)

1186 OBSERVED PROPERTIES OF QUASI-STELLAR OBJECTS. Schmidt, M. (Mount Wilson Observatory, Pasadena, Calif. Palomar Observatory, Pasadena, Calif.). pp 467-9 of Contemporary Physics: Trieste Symposium 1968. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.1); CONF-680629(Vol.1).

The review is limited to a summary of the observed properties of quasars including radio properties, optical continuum, distribution, isolated star-like objects, optical variations, emission-line spectra, redshifts, absorption-line spectra, and redshift–magnitude relation. (W.D.M.)

1187 ATTEMPTS AT OPTICAL DETECTION OF PULSARS. Cameron, A. G. W. (Yeshiva Univ., New York). pp 475-6 of Contemporary Physics: Trieste Symposium 1968. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.1); CONF-680629(Vol.1).

A very brief account is given of the first attempts to detect optical pulses from the pulsar CP 1919. All attempts produced negative results. (W.D.M.)

1188 NATURE OF PULSARS. SURVEY OF PRESENT VIEWS. Gold, T. (Cornell-Sydney Univ. Astronomy Center, Ithaca, N. Y.). pp 477-81 of Contemporary Physics: Trieste Symposium 1968. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.1); CONF-680629(Vol.1).

The constraints upon any theory that attempts to explain pulsars are discussed. Pulsar models must invoke emitting regions that are remarkably small and intense, and only a coherent motion of charges can reasonably provide such radiation densities. Secondly, high-density matter has to be invoked in order that such a concentration of energy can be held together for long periods of time and in order to provide dynamical time constants that are short enough and that allow one to account for the extreme regularity. Current models are discussed based on pulsating white dwarfs, pulsating neutron stars, rotating white dwarfs, neutron stars with orbiting planet, neutron star binaries, or neutron stars with rotating magnetospheres. The last seems best capable of giving some of the observed features although there, as in the other cases, the radiation mechanism is not understood. (auth)

1189 BALLOON OBSERVATION OF CygX-1 AND ISOTROPIC COMPONENT OF X RAYS. Makino, Fumiyoshi; Tanaka, Yasuo (Nagoya Univ., Japan). Tokyo Daigaku Uchu Koku Kenkyusho Hokoku, 5: 167-9(Mar. 1969). (In Japanese).

X-ray intensity of the CygX-1 and the isotropic component of x rays were measured in the energy region of 26 ~ 70 keV. The apparatus for x-ray observation was a combination of NaI(Tl) and plastic scintillators provided with two collimators of different solid angles, carried by a balloon. Measured values of the mean intensity are consistent with previous measurements. Because of

the failure of the apparatus during the observation, obtained data were statistically insufficient to say anything certain about the time variation of Cyg X-1. (auth) (NSA of Japan)

1190 FORMATION OF ENERGY SPECTRA IN SYNCHROTRON SOURCES. Melrose, Donald B. (Univ. of Maryland, College Park). Astrophys. Space Sci., 5: 131-49(Oct. 1969).

The observed energy spectra in synchrotron sources are power laws, $N(E) = KE^{-\gamma}$, with the distribution in γ peaked around 2.5. These are consistent with initially injected spectra with γ between 1 and 2, subsequently steepened by synchrotron losses. Contrary to the results of Kardashev (1962), it is shown that statistical acceleration when coupled with synchrotron losses lead naturally to the formation of flat stationary spectra with $\gamma \leq 1$. These stationary spectra have bends near the energy at which synchrotron losses balance the energy gains by acceleration. Above this bend the spectrum tends to $\gamma = 2$. The time evolution of an initial spectrum towards the stationary spectrum is investigated. It is suggested that the initially flat spectra with $\gamma \simeq 1$ to 1.5 observed in some variable sources result from an incomplete approach to the stationary spectrum, and that in sources with constant acceleration spectra with $\gamma \simeq 2$ are to be expected. (auth)

1191 RADIOEMISSION OF THE CP-1919 PULSAR IN THE REGION OF METER WAVES. Alekseev, Yu. I.; Vitkevich, V. V.; Shitov, Yu. P. (Lebedev Inst of Physics, Moscow). Dokl. Akad. Nauk SSSR, 187: 291-3(July 11, 1969). (In Russian).

Regular observations on the pulsar were carried out in April to July of 1968 at a frequency of 93 Mc and separately at frequencies of 110, 106, 92, 73, and 61 Mc. The receiver transmission bands were varied from 0.08 to 1.0 Mc with a time constant varied from 0.05 to 0.15 sec. An analysis of the pulse delay times at various wavelengths shows a squared dependence of the change in delay time as a function of the wavelength. This behavior indicates that the reason for the pulse delay at longer wavelengths is the difference in their group velocities in the interstellar plasma. The total number of electrons in a column having an area of 1 cm^2 which would create this delay is 3.8×10^{19}. This figure corresponds to a distance equal to 4000 light years at a density of 0.01 electrons per cm^3. On the average a decrease in radiation intensity from this source was observed from April to July of 1968. A characteristic rise time of about one second with a slower fall in radiation intensity was noted. At present it is thought that a pulsar is probably a white dwarf with radial oscillations, or a rotating object, in particular, a neutron star. The rapid rise and slow fall of the pulse amplitudes indicate that the pulsar is a neutron star of some sort. (TTT)

1192 RADIO STRUCTURE OF TYCHO'S SUPERNOVA REMNANT. Dickel, J. R. (Univ. of Illinois, Urbana). Astrophys. Lett., 4: 109-12(Oct. 1969).

Observations were made of Tycho's supernova remnant at a wavelength of 2 cm with a resolution of 2 arc min. They show either a ring, or very irregular shell structure, for the remnant. Several interesting polarized features are noted. (auth)

1193 OBSERVATIONS OF VARIABLE RADIO SOURCES. Grahl, B.-H. (Max-Planck-Institut fuer Radioastronomie, Bonn); Grewing, M. Astrophys. Lett., 4: 107-8(Oct. 1969).

Six radio sources expected to be variable were repeatedly observed during the first half year of 1968 at a frequency of 2.695 GHz. Additional measurements were obtained in February and March 1969. Combined with measurements quoted in Kellermann and Pauliny-Toth (1968) the recent results indicate pronounced variations in the flux from 3C 345 and PKS 1510-08 and minor changes for most of the remaining sources. (auth)

1194 ROTATING COLLAPSED OBJECTS, QUASARS, AND SUPERNOVA REMNANTS. Cavaliere, A. (Laboratorio Gas Ionizzati, Frascati, Rome. Istituto di Fisica, Bologna); Pacini, F.; Setti, G. Astrophys. Lett., 4: 103-5(Oct. 1969).

By analogy with the case of the Crab Nebula, it is suggested that the high energy activity of quasars and similar objects may result from the presence of a spinning, magnetic, supermassive star. (auth)

1195 RECOMBINATION LINES IN THERMAL AND NON-THERMAL GALACTIC SOURCES. Milne, D. K. (CSIRO, Sydney); Wilson, T. L.; Gardner, F. F.; Mezger, P. G. Astrophys. Lett., 4: 121-7(Oct. 1969).

The continuum spectra of 54 well-resolved galactic sources are compared with the intensity of the H109α recombination line at 5009 MHz. It is concluded that thermal sources generally exhibit a H109α line stronger than 3% of the continuum while non-thermal sources show little or no recombination line. (auth)

1196 UNUSUAL RADIO SOURCE OQ 208. Ryle, M.; Pooley, G. G. (Mullard Radio Astronomy Observatory, Cambridge, Eng.). Astrophys. Lett., 4: 137-8(Oct. 1969).

The radio source OQ 208 appears to be associated with a blue stellar object lying 10 arc sec from a 13 mag galaxy. (auth)

Solar Phenomena

Refer also to abstract 1329.

1197 IS THE SUN A MAGNETIC ROTATOR. Severny, A. (Crimean Astrophysical Observatory, Moscow). Nature (London), 224: 53-4(Oct. 4, 1969).

Measurements of the general polar magnetic field of the Sun show that since Sept. 1964 the Sun has behaved on average like a dipole with a negative field strength at the N pole and an approximately equal positive field at the S pole; but because of a bias toward the area of negative polarity in the northern hemisphere the net magnetic flux was on average negative most of the time, and in this sense the Sun behaved like a "monopole." There have been, however, large deviations from the mean; for example, sometimes both poles had a field of the same sign, and during the first half of 1964 the mean strength at the S pole was zero. More or less regular measurements of the magnetic field of the solar disk were commenced in 1967 using a parallel beam from the coelostat mounting falling on the magnetograph slit of the Crimean solar tower telescope. This method gives directly the mean longitudinal field strength, and the important point about the measurements is the fixation of zero for the field strength. All measurements are from chart recordings of the photoelectric signal arising from Zeeman splitting of the magnetic sensitive line λ 5250 Fe I, together with simultaneous use of the magnetic insensitive line λ 5123 Fe I to record the actual position of zero. The magnetic field strength under consideration is the difference between the mean reading for λ 5250 and the mean for λ 5123. The values obtained are shown plotted for March to June 1968. The measurements include the contribution from sunspots, for which correction is made. Fluctuations of the magnetic field of the Sun as a whole clearly show periodicity in change of polarity; twice in the course of one rotation (27 days) there was positive and negative polarity. The period defined by the large peaks observed is 27.1 days, coinciding with the period of solar rotation, and the mean time interval between successive peaks of the same polarity is 14.5 days, or about half the rotation period. This behavior of the Sun, like a rotating magnetic quadrupole, could in principle be explained by a corresponding distribution of active regions on the solar surface, with large "bipolar" regions each occupying the equatorial regions for about 180° in longitude. The observations lead to the expectation of a four-sector structure of the interplanetary field during the period considered, if there is close correlation between this field and the general magnetic field of the Sun. (UK)

1198 FLIGHT TIME OF SOLAR FAST PARTICLES FROM FLARES TO THE EARTH. SUPPLEMENT II. Krivsky, L. (Astronomical Inst., Ondrejov, Czech.). Bull. Astron. Inst. Czech., 20: 293-6(1969).

Ejections of solar fast particles from flares that produce PCA (polar cap absorption) and GLE (ground level effect—increase of cosmic rays) effects are considered to originate in flares with a Y-shaped phase of development at the time of their rapid blaze up (Křivský, 1963, 1965, 1968). Thus, the exact time of the ejection and escape of the particles is known, coincident with the first maximum of radio emission in the cm and dm range (Křivský, 1963) and with peaks of very hard x emission (Valníček, 1967). The time lag of the beginning of the PCA effect or of the beginning of the cosmic-ray increase after the occurrence of the Y-shaped phase of the flare is determined. With cosmic rays the delay time ranges between 3 and 85 minutes, with particles producing the PCA effect it ranges from 10 to 870 minutes. Listed are data on further flares with a Y phase and on various particles effects. Corrections of supplementary data for the flares and flight times of particles already published (Křivský, 1965, 1966) are given. (auth)

1199 ANOTHER CONTRIBUTION TO THE QUESTION OF THE JOULE DISSIPATION OF MAGNETIC FIELDS IN THE SOLAR ATMOSPHERE. Kopecky, M. (Astronomical Inst., Ondrejov, Czech.). Bull. Astron. Inst. Czech., 20: 296-300 (1969).

If the magnetic field dissipates in the elements of its fine structure, it may dissipate, to a great extent, during the lifetime of a spot group even though the dissipation is determined by electric currents flowing in regions of high electric conductivity. In certain conditions, the Joule dissipation may therefore play an important role in the life of magnetic fields in the solar atmosphere. In this connection there also arises the question of the possibility of a continuous formation of magnetic fields in the solar atmosphere. (auth)

1200 ANALYSIS OF A METHOD OF WIDE-SLIT PHOTOMETRY OF CORONAL LINES. Rusin, V.; Rybansky, M. (Astronomical Inst., Skalnate Pleso, Czech.). Bull. Astron. Inst. Czech., 20: 300-3(1969).

The analysis of a method used in photometry of emission lines of the corona is presented. It is shown that the method is accompanied by a systematic error. Causes of the occurrence of this error, the magnitude of the latter in dependence on different factors are ascertained, and a suggestion is presented on how to eliminate the error by varying the observation method. (auth)

1201 PROPAGATION OF COSMIC RADIATION THROUGH THE INTER-PLANETARY MAGNETIC FIELD. McCracken, K. G. (Univ. of Adelaide). Proc. Astron. Soc. Aust., 1: 29-30(Jan. 1967).

Instruments were flown on the Pioneer 6 and 7 spacecraft during 1965-66 to study the degree of anisotropy of cosmic radiation in the energy range 7.5 to 90 MeV/nucleon. The instruments record the cosmic-ray fluxes from each of four contiguous quadrants of azimuthal rotation of the spacecraft for each of 3 energy windows 7.5 to 45 MeV, 45 to 90 MeV, and 150 to 350 MeV for α particles and heavier nuclei. In addition, the counting rate of all particles of energy >7.5 MeV is recorded, thereby providing cosmic-ray data of high statistical precision useful in the study of fast changes in the cosmic-ray flux. During the first 6 months of flight of Pioneer 6, some 16 solar flares were detected in which the integral proton fluxes for energies >7.5 MeV were >0.005 protons $cm^{-2}sec^{-1}$. The protons of solar origin were usually grossly anisotropic, the anisotropies persisting for periods in excess of 24 hr on some occasions. Observations of the >7.5-MeV cosmic radiation revealed a persistent 27-day recurrence series in the low-energy cosmic radiation. Each recurrent depression in the cosmic-ray intensity exhibited the rapid onset, and gradual recovery which typifies the "Forbush decrease" type of cosmic-ray variation. A verification of the co-rotating shock model is provided by the observation of the same Forbush decrease by both Pioneer 6 and Pioneer 7. (BBB)

1202 GAMMA-RAY BURST OF THE SUN. Okudaira, Kiyoaki; Hirashima, Hiroshi (Rikkyo Univ., Tokyo). Tokyo Daigaku Uchu Koku Kenkyusho Hokoku, 5: 161-6(Mar. 1969). (In Japanese).

Balloon observation was made on Sept. 27, 1968 to detect, with a phoswich scintillation spectrometer, the γ radiation accompanying the solar flare. During the observation, rapid increase in γ-ray intensity was observed at 0345 UT, simultaneously with a radio burst of the Sun. This increase was considered as due to a γ-ray burst on the solar sphere because of the coincidence with the radio burst and of the high geomagnetic cutoff at the location of observation. The energy spectra were composed of several line spectra. At the peak in the region of 1.4 to about 1.7 MeV, which was statistically most significant, the increase exceeded 5σ. Duration of the burst was, at most, about one minute. (NSA of Japan)

1203 ZODIACAL LIGHT AT THE NORTH ECLIPTIC POLE. Wolstencroft, R. D.; Roach, F. E. (Univ. of Hawaii, Honolulu). Astrophys. J., 158: 365-9(Oct. 1969).

A critical evaluation is given of some recent measurements of the zodiacal light, with particular reference to its brightness at the north ecliptic pole. (auth)

1204 RAPIDLY ROTATING CORE AND SOLAR NEUTRINOS. Ulrich, Roger K. (California Inst. of Tech., Pasadena). Astrophys. J., 158: 427(Oct. 1969).

Solar models were constructed with the hydrostatic equation perturbed by the centripetal acceleration from a rapidly rotating core. These models show that the observed low counting rate of solar neutrinos cannot be due to this cause. (auth)

1205 TURBULENCE, VISCOSITY, AND DISSIPATION IN THE SOLAR-WIND PLASMA. Coleman, Paul J. Jr. (Univ. of California, Los Angeles). pp 333-58 of Turbulence of Fluids and Plasmas. Fox, Jerome (ed.). Brooklyn, Polytechnic Press of the Polytechnic Inst. of Brooklyn, 1969.

From Symposium on Turbulence of Fluids and Plasmas, New York. See CONF-680431.

Power spectra of the solar-wind magnetic field B and the radial component of the solar-wind plasma velocity V are described. The spectra were calculated from measurements obtained in 1962 with instruments on board the spacecraft Mariner 2. The spectral estimates extend over the frequency range from one cycle per 32 days to 1.35×10^{-1} Hz. From the properties of the plasma fluctuations, as determined from the spectra, it is tentatively concluded that the solar-wind flow is often turbulent in the region near 1.0 a.u. A heuristic model of the turbulent flow that is consistent with the observations is one in which the energy for the turbulence is derived from the differential motion of the streams in the solar-wind plasma. Instabilities associated with the differential streaming produce long-wavelength Alfvén waves. The magnetohydrodynamic turbulence is composed of a hierarchy of Alfvén waves of shorter wavelengths which is generated in turn by nonlinear processes. The energy extracted from the differential motion cascades through the hierarchy until it reaches waves short enough to interact directly with the positive ions. The energy in these shorter waves is then dissipated in heating the protons through cyclotron damping. As a result of the turbulence the differential motion of the plasma streams is eliminated and the flow eventually becomes laminar and nearly radial from the sun. (auth)

1206 SOLAR NEUTRINO ASTRONOMY. Fowler, W. A. (California Inst. of Tech., Pasadena. Inst. of Theoretical Astronomy, Cambridge, Eng.). pp 359-70 of Contemporary Physics: Trieste Symposium 1968. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.1); CONF-680629(Vol.1).

The current experimental, observational, and theoretical situation in regard to the flux of neutrinos from the Sun is reviewed. It is concluded that there are no reasons at the present time to question seriously the fundamental concepts of stellar structure and evolution. (auth)

1207 MEASURING THE WHOLE-SUN INTENSITY AT DECIMETER WAVELENGTHS. Landecker, T. L. (Univ. of Sydney). Proc. Astron. Soc. Aust., 1: 61-2(Nov. 1967).

Accurate absolute measurements of the total emission from the Sun at decimeter wavelengths are described, and the present state of knowledge of the Sun's decimeter spectrum is reviewed. An absolute calculation at 1420 MHz is considered as an example of technique. The features of the solar spectrum discussed are difficult to reconcile with the current view, that the sources of the S component are radiating thermally, and that magnetic fields affect this radiation only at frequencies above 3000 MHz. For this reason more absolute measurements of the Sun are needed. More 1420-MHz measurements will be made, as well as an absolute calibration at 720 MHz. (BBB)

1208 THE 158-MHz SOLAR INTERFEROMETER AT CULGOORA. Stewart, R. T. (CSIRO, Sydney). Proc. Astron. Soc. Aust., 1: 59-61(Nov. 1967).

A description is given of the function of the 158-MHz interferometer operating at the CSIRO Solar Observatory, Culgoora, in the measurement of solar radio-burst positions at a frequency close to the second harmonic frequency of the radioheliograph. The interferometer is designed to measure the north-south and east-west position co-ordinates of an isolated active region on the Sun with an accuracy of ~1′ arc, at rates up to 16 sec^{-1}. An example of the derived position co-ordinates of a group of spectral Type-III bursts with intensities as weak as that of the quiet Sun is shown. (BBB)

1209 A NEW COMPOUND INTERFEROMETER OPERATING AT 160 MHz AT NOBEYAMA. Takakura, T.; Tsuchiya, A.; Morimoto, M.; Kai, K. (Tokyo Univ.). Proc. Astron. Soc. Aust., 1: 56-8(Nov. 1967).

During the last solar cycle, observations of solar radio emissions were made in a wide frequency range, from which an enormous amount of information was obtained. However, the results obtained so far are limited by poor angular resolution. Observations with much higher resolution (of order of 1′ arc) are required for further studies of solar radio emissions. A high-resolution study of radio bursts in the meter-wave range, and the construction of a new compound interferometer operating at 160.3 MHz are described. (BBB)

1210 TECHNIQUES FOR DECIMETER WAVELENGTH OBSERVATIONS OF RADIO PLAGES AND BURSTS. Christiansen, W. N. (Univ. of Sydney). Proc. Astron. Soc. Aust., 1: 55(Nov. 1967).

Solar radio observations obtained with a new radio telescope are described. Two-dimensional solar maps at $\lambda = 21$ cm were made 2 or 3 times a week with a grating cross. An east-west compound interferometer was used to scan the Sun each day at a wavelength of 21 cm to determine the one-dimensional brightness distribution over the Sun at a resolution of 35 in. In addition lower resolution fan-beam scans were made at a wavelength of 43 cm. Use was made of the independent outputs from each antenna of the east-west compound interferometer to derive almost instantaneously the one-dimensional brightness distribution over the Sun. This type of observation was used when the Sun shows some burst activity. The resolution was about 35″ at $\lambda = 21$ cm and 1.2′ at $\lambda = 43$ cm. (BBB)

1211 THEORETICAL LINE PROFILES FOR HYDROGEN AND CALCIUM UNDER CHROMOSPHERIC CONDITIONS. Black,

R. B. T. (Univ. of Sydney). Proc. Astron. Soc. Aust., 1: 52-3 (Nov. 1967).

High-resolution Hα photographs have confirmed that much of the solar chromosphere is nonuniform, and consists of many distinct structures, which have a typical transverse section of several seconds of arc, i.e., about 2000 km. The nonuniform chromosphere was analyzed by first investigating a single structure. A simple model of a structure was chosen. From the model, line profiles of Hα and the H and K lines of Ca II were computed assuming a variety of physical conditions to exist in the feature. Line profiles of Hα are shown for different values of electron density, all at the same temperature. The change in the profile as the electron density increases is striking. At low values, only the reflected and transmitted incident radiation contributes to the emergent profile. As the electron density is increased, the self-emission increases rapidly to dominate the shape of the profile, giving the characteristic double-peaked shape. Also illustrated are the changes in the profiles of Hα with increasing temperature at constant electron density. The Ca profiles are very similar to those of Hα. The major difference lies in the variation of intensity with temperature. (BBB)

1212 IMPULSIVE X-RAY EMISSIONS BY THE SUN. Harries, J. R. (Univ. of Adelaide). Proc. Astron. Soc. Aust., 1: 51-2 (Nov. 1967).

Solar x-ray bursts were observed by a xenon–methane-filled proportional counter on the satellite IMP-F. The solar x-ray flux was observed to consist of impulsive bursts of x rays with a time scale of about one hr superimposed on a slowly varying x-ray flux with a time scale of about three days. The relation of the individual x-ray bursts to other forms of solar activity is being investigated. An x-ray burst and the solar radio emission bursts over the same period are illustrated. The background shows no variation, indicating that the increase could not be due to charged particles. The radio burst shows a close agreement with x-ray burst, the time scale of the x-ray event being almost the same as the event observed at 2800 MHz, and a secondary peak of both x rays and radio emission occurring at 2110. Two other radio bursts are shown: one is very short and has no associated x rays, while the other at 2316 has a slight associated x-ray increase. During very active periods many x-ray bursts occurred together. During this period two optical flares and four or five radio bursts were observed, most of which were accompanied by x-ray emission. (BBB)

1213 EVOLUTIONAL FEATURES OF SOLAR MICROWAVE TYPE IV BURSTS. Kai, K. (Tokyo Univ.). Proc. Astron. Soc. Aust., 1: 49-50 (Nov. 1967).

Large outbursts from the Sun, which are widely extended over centimeter and decimeter ranges, and show smooth time variations in intensity are called microwave type-IV bursts(μ-IV). These bursts generally consist of more than two successive components, the spectra of which move progressively towards the lower frequencies. A quantitative study of the time variation of the decay times and flux densities of μ-IV burst spectra was made, and an analysis of how the physical conditions in the source change with time is presented. Twenty-three μ-IV bursts were selected in the period 1958 to 1967. Observations were made at 1000, 2000, 3750, 9400, and 17,000 MHz. Spectra and decay times were derived from observational data for each successive component of the μ-IV bursts. The results suggest that the source of μ-IV bursts moves progressively upwards in the atmosphere where the magnetic field is weaker. This point is to be checked with the aid of high-resolution interferometers operating at 9.4 and 4.0 GHz. At the same time the radiated power decreases with time. Successive eruptions following the first one do not occur continuously but rather intermittently. The observations indicate that the accelerating regions move upwards continuously but the real acceleration takes place only when an injection of electrons occurs. The importance of high-frequency observations for the future study of μ-IV bursts is suggested. (BBB)

1214 HIGH RESOLUTION SOLAR OBSERVATIONS AT THREE FREQUENCIES: 1424 MHz, 696 MHz, AND 408 MHz. Cole, D. G.; Mullaly, R. F.; Watkinson, A. (Univ. of Sydney). Proc. Astron. Soc. Aust., 1: 45-6 (Nov. 1967).

During the period July 12 to August 5, 1966 observations were made of the Sun at three radio observatories. The instruments used were the east–west arm of the Mills cross at Molonglo (408 MHz) and the Christiansen cross at Fleurs (696 MHz and 1424 MHz). The aim was to study the discrete sources of the slowly varying component of solar radio emission, while activity was comparatively quiet. The three frequencies enabled the variation of source structure with height of solar atmosphere to be studied. The mean heights observed are listed in a table along with other characteristics observed. The 1424-MHz results agreed fairly well with previous heights obtained at this frequency. The 408-MHz sources appeared in all cases to be higher than the 1424-MHz sources, the range being 90 to 200×10^3 km above the photosphere. The discrete sources at 408 MHz appeared more prone to intensity fluctuation than at higher frequencies. The 696-MHz observations were characterized by the broad sources, while the narrow sources seen at 408 MHz did not appear. The 696-MHz sources were consistent with 1424-MHz sources, which were associated with the more intense optical plage regions. It was found that the radio-source structure trails behind the optical plage regions up to heights of ~100,000 km, above which it bends forward in the direction of solar rotation. (BBB)

1215 PRELIMINARY RESULTS FROM A 35"-ARC COMPOUND INTERFEROMETER. Wellington, K. J.; Watkinson, A. (Univ. of Sydney). Proc. Astron. Soc. Aust., 1: 44-5 (Nov. 1967).

Radio astronomy observations with the new Fleurs compound interferometer are described. This instrument operates at 21 cm and has a fan-beam response 35-in. arc wide in an east–west direction. An arrangement provides fan-beam responses across the sky at intervals of ~1°. Conclusions that can be drawn from the observations to date are provided. The undisturbed Sun and its slowly varying or 'S' component almost invariably contains some fine structure of low intensity (i.e., less than 1′ arc and less than 1 solar flux unit). These regions are usually but not necessarily associated with the more intense regions previously observed. Most of the S component features in this part of the solar cycle are resolved at some 1.5′ (range 5 to 40 s.f.u.). With a sample of three bursts there was in every case some fine structure associated with the plage. The intensity of this component increased greatly during the burst but diminished to its former value before the burst ended. In one case it reached a maximum before the peak of the burst. Small features that appear in the central portion of a larger region before a burst may lead to a new method of predicting solar activity. (BBB)

1216 OBSERVATIONS OF THE SUN WITH THE MOLONGLO CROSS. Little, A. G. (Univ. of Sydney). Proc. Astron. Soc. Aust., 1: 42-3 (Nov. 1967).

Transit observations of the Sun were made with the Molonglo radio telescope at 408 MHz. Thus the Sun was scanned once per day by eleven separate beams evenly spaced in declination. Two observations are discussed. First, the way in which the intensity falls off at the limb is of considerable interest because of the possibility of limb brightening, and, second, the positions, intensities, and sizes of the bright regions are of importance. As far as the active regions are concerned, several bright regions were observed. On July 25 and 26, two bright regions were on the eastern limb, and were close together. Each was about the size of the beamwidth and hence were small, no more than 1 to 2′. A large spot group was located midway between the two. Two transient, small regions were observed in a series of 3 days' observations on September 2, 3, and 4. The contour maps for these are shown. These observations show the sort of phenomena expected from observations with the pencil beam of the Molonglo cross. (BBB)

1217 RADIO STUDIES OF THE QUIET SUN AT DECIMETER AND METER WAVELENGTHS. Sinha, R. P.; Swarup, G. (Tata Inst. of Fundamental Research, Bombay). Proc. Astron. Soc. Aust., 1: 41-2 (Nov. 1967).

The radio spectrum of the limb of the quiet Sun is brighter in the equatorial regions than near the pole, but most theoretical calculations of the brightness distribution over the quiet Sun have been made assuming spherical symmetry. Therefore calculations were made of two-dimensional distributions at several decimeter and meter wavelengths, taking account of the observed asymmetry in the north–south direction. Preliminary results (particularly for a sunspot minimum period) are presented which indicate that the electron temperature of the corona has a value of about 1 to 1.5×10^6°K. Isolated sources of the slowly varying component were studied at 610 MHz. The highest values of brightness temperature were found to be 1×10^6, 1.1×10^6, 1.5×10^6, and 1.7×10^6°K for regions with central meridian passage of September 28, 1966, October 3, 1965, April 2, 1966, and March 21, 1966 respectively. The electron temperature of the corona has a higher value near the active regions than in the quiet parts. However, because the above sources at 610 MHz have the large size of 10′, 6.6′, 7.3′, respectively, it is assumed that the peak observed values of about 1.5×10^6°K represents the electron temperature of the quiet rather than the active solar corona. (BBB)

1218 THE RADIOHELIOGRAPH AND THE RADIO ASTRONOMY PROGRAM OF THE CULGOORA OBSERVATORY. Wild, J. P. (CSIRO, Sydney). Proc. Astron. Soc. Aust., 1: 38-9 (Nov. 1967).

The radio astronomy installations and research at Culgoora Observatory are described. A new spectrograph covering a wide frequency range (5 to 8000 MHz) was built with special emphasis

to design factors which would yield ease of data reduction and high sensitivity. A second research instrument designed specifically in support of the radioheliograph is a 158-MHz interferometer to locate instantaneous positions of bursts in two dimensions with an accuracy of 1′ arc. The frequency of 158 MHz was chosen in a clear band close to the second harmonic of the radioheliograph frequency (80 MHz) to provide occasional opportunities of simultaneously locating the fundamental and harmonic sources of type-II and type-III bursts. The first solar observation recorded with the completed instrument was obtained in 1967 and is illustrated. The event was a sequence of bursts of very low intensity but provided a remarkable demonstration of apparently connected activity in widely spaced regions of the Sun. While some bursts occurred in one region beyond the limb of the Sun, other bursts occurred in another, nearly 2 $R_\odot$ away. Each photograph was exposed for a period of about 1½ min containing the burst designated, the long exposure being required to give a clear picture of the quiet Sun. A 1-sec exposure of a storm region, which developed above and shortly after an Hα flare, is also illustrated. (BBB)

Galaxies

1219 HYDROMAGNETIC STABILITY OF THIN SELF-GRAVITATING DISKS AND SPIRAL STRUCTURE. **Hosking, R. J. (Flinders Univ. of South Australia, Bedford Park). Aust. J. Phys., 22: 505-19(Aug. 1969).**

The hydromagnetic stability of infinitesimally thin, current-carrying, differentially rotating disks is considered. The perturbation theory described is first order (linear) throughout. It is shown that azimuthal electric current produces instability for all (radial) wavelengths. The case of radial equilibrium electric current reduces to the nonhydromagnetic problem treated by Lin and Shu (1964), although hydromagnetic effects are expected for a disk of finite thickness or to second order due to azimuthal perturbation current. (Australia)

1220 MASS–RADIUS RELATION FOR ELLIPTICAL GALAXIES. **Genkina, L. M. (Astrophysical Inst., Alma-Ata, USSR). Bull. Astron. Inst. Czech., 20: 303-4(1969).**

The relation between masses and radii is of essential importance for the theory of galaxy formation. Genkina and Ozernoi (1968) noted qualitatively that Sérsic (1968), using the effective radii R_e and masses M of elliptical galaxies according to Fish (1964), divided E galaxies into two groups without sufficient reason and for each of them a wrong relation law $M \sim R_e^{\frac{1}{2}}$ was obtained. Quantitative data to support this point of view are given. A reply by Sérsic is included. (W.D.M.)

1221 DIFFUSE MATTER IN SPACE. **Spitzer, Lyman Jr. Interscience Tracts on Physics and Astronomy. No. 28. New York, John Wiley and Sons, Inc., 1968. 274p. $11.50.**

A brief historical introduction, together with a description of the gravitational limit on the local density of interstellar material, is given. The primary observational results on which the subsequent theory must be based are summarized in a very abbreviated form. The physical processes which are associated with encounters between various types of interstellar particles are treated. A brief introduction to problems of interstellar gas dynamics is given. Some of the various phenomena that may be important in a future theory of star formation are discussed. (W.D.M.)

1222 SEYFERT GALAXIES. **Kwast, Tomasz. Postepy Astron., 17: 267-79(Sept. 1969). (In Polish).**

The main characteristics of the Seyfert galaxies are a small bright nucleus in the center and strong emission lines (up to 10,000 km/sec). Additionally, these galaxies emit strong infrared radiation and some of them are radio sources or variable. Shape, color indices, and bolometric luminosities of the Seyfert galaxies are intermediate between these features for the normal galaxies and quasars. According to the principal model of the Seyfert galaxy, high temperature and strong emission arises because of either fall of matter or explosion of a supernova. Radio and infrared radiation is due to synchrotron emission of relativistic electrons spiraling in a compressed magnetic field. However, no theory agrees completely with the observations. According to other hypotheses, part of the phenomena are effects of gravitational lenses. (auth)

1223 THERMAL PROPERTIES OF INTERSTELLAR GAS HEATED BY COSMIC RAYS. **Goldsmith, D. W.; Habing, H. J.; Field, G. B. (Univ. of California, Berkeley). Astrophys. J., 158: 173-83(Oct. 1969).**

Detailed calculations are presented of thermal properties of predominantly neutral interstellar gas heated by low-energy cosmic rays. The heating rate does not depend on the form of the energy spectrum of the cosmic rays, but only on an integral over the spectrum. This integral is proportional to the ionization rate ζ. It is shown that two heating processes are important: (i) heating of the free electrons of the gas by direct interaction with cosmic rays and (ii) heating caused by electrons liberated by cosmic-ray particles, which electrons transfer part of their energy to the free electrons of the gas. If the electron density is low (less than $0.02\ n_H$), the second process dominates; otherwise, both processes must be considered. Calculations of thermal equilibrium show that the kinetic pressure in the gas has a maximum at an atomic density of about 0.2 cm^{-3}. This leads to a model in which the interstellar gas is represented by two thermally stable phases in pressure equilibrium — a rarefied one at about 10^4°K and a dense one at about 100°K. The influence on equilibrium temperatures of lowering abundances by accretion of trace elements on grains is discussed. Evidence is presented for underabundance of all trace elements observed in the interstellar gas. (auth)

1224 THE REDDENING OF M3, M13, M31, AND M33 FROM PHOTOMETRY OF LATE-TYPE FIELD STARS. **McClure, Robert D. (Kitt Peak National Observatory, Tucson, Ariz.); Racine, Rene. Astron. J., 74: 1000-7(Oct. 1969).**

A new method for the determination of the interstellar reddening of late-type stars was developed and applied in the direction of the high-latitude globular clusters M3 and M13, and of the two spiral galaxies M31 and M33. The color excess for both globular clusters was found to be zero: $E(B-V) = -0.01 \pm 0.02$ for M3, and $E(B-V) = 0.00 \pm 0.02$ for M13; further, it was found that $E(B-V) = 0.11 \pm 0.02$ for M31, and $E(B-V) = 0.03 \pm 0.02$ for M33. In the direction of M31, the absorbing material appears to extend to a distance of 200 ± 50 pc below the galactic plane. (auth)

1225 INTERSTELLAR REDDENING FOR GLOBULAR CLUSTERS M3 AND M13. **Crawford, David L.; Barnes, Jeannette V. (Kitt Peak National Observatory, Tucson, Ariz.). Astron. J., 74: 1008-10(Oct. 1969).**

Results of four-color and Hβ photometry of A- and F-type stars in the areal vicinity of M3 and M13 were used to conclude that the space reddening, E(b−y), in front of these clusters is nearly zero: 0.004 m for M3 and 0.011m for M13. (auth)

1226 PHOTOMETRIC STUDIES OF SOUTHERN GALACTIC CLUSTERS. II. IC 2602. **Hill, Graham (Dominion Astrophysical Observatory, Victoria, British Columbia. Cerro Tololo Inter-American Observatory, La Serena, Chile); Perry, Charles L. Astron. J., 74: 1011-21(Oct. 1969).**

Multicolor photometry is presented for 33 stars in the vicinity of the southern galactic cluster IC 2602. Independent analyses of UBV and uvby−Hβ data confirm that IC 2602, with a minimum membership of 31 stars, is reddened by 0.035m and is located at a distance of 150 pc. These analyses show that the absolute magnitude calibrations and intrinsic color relations derived from both UBV and uvby−Hβ photometry are in good agreement. An upper limit to the nuclear age of 4×10^6 yr and a lower limit to the contraction age of 20×10^6 yr were obtained for the cluster. Hence star formation was not coeval in IC 2602. The uvby−Hβ data fit the standard relations of the Hyades Cluster, although there is only limited overlap for the fainter members. (auth)

1227 OPTIMIZATION IN STELLAR HYDRODYNAMICS INVOLVING KINETIC THEORY. **von Krzywoblocki, M. Z. (Michigan State Univ., East Lansing). Rev. Roum. Sci. Tech., Ser. Mecan. Appl., 13: 1133-42(1968).**

The main aspects of optimization techniques are presented, including numerical techniques suitable for high-speed digital computers allowing handling of some optimization problems involving partial differential equations. The inverse optimization technique involving some observational data seems to be adaptable for solving problems in stellar hydrodynamics. This technique can be applied to calculate the correct form of the distribution function in stellar kinematics, the correct values of some characteristic functions in the theory of a galaxy of stars, and in the theory of the dynamics of a cosmic gas, interstellar structures, especially those of gas clouds. If reliable experimental data related to the turbulence in the galactic systems or in star clusters were available, the inverse optimization technique would allow one to calculate the proper structures of functions appearing in the correlation forms. Under certain assumptions the effect of stellar encounters can be disregarded in galactic dynamics. Problems of the distribution function, the coefficients of the velocity ellipsoid, solutions for these coefficients, for the motions of the local centroids in various cases like the two-dimensional problems, systems with circular symmetry, nonsteady states, and axial symmetry offer many possibilities of application of the inverse optimization technique to calculate variables which are difficult to measure experimentally. (BBB)

1228 THE HIGH-VELOCITY HYDROGEN CLOUDS CONSIDERED AS SATELLITES OF THE GALAXY. Kerr, Frank J.; Sullivan III, Woodruff T. (Univ. of Maryland, College Park). Astrophys. J., 158: 115-22(Oct. 1969).

The high-velocity hydrogen clouds at high latitudes have been widely discussed as material falling into the galactic disk from outside. The observed velocities show strong effects arising from the galactic rotation at the Sun's position. When this rotation is removed from the calculations, the residual velocities are compatible with the clouds being in highly eccentric orbits around the Galaxy at distances of the order of 50 kpc. New observations are proposed which may help to decide between galactic and extragalactic interpretations. A solar-motion solution for a sample of sixty-two high-velocity clouds with $|b| > 20°$ yields a velocity of 222 km sec^{-1} with respect to the local standard of rest toward $l = 136°$, $b = -4°$. (auth)

1229 LARGE-SCALE SHOCK FORMATION IN SPIRAL GALAXIES AND ITS IMPLICATIONS ON STAR FORMATION. Roberts, W. W. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J., 158: 123-43(Oct. 1969).

The dynamical problems of shock formation and star formation in normal spiral galaxies are investigated. The motion considered is that of the continuum of turbulent gas composing the gaseous disk moving in a gravitational field consisting of a two-armed spiral field superposed on the Schmidt model for the Milky Way system. The possible existence of a stationary two-armed spiral shock pattern is demonstrated. It is suggested that galactic shock waves may very well form the triggering mechanism for the gravitational collapse of gas clouds, leading to star formation. If an upper bound of 30 million years is assumed for the process of formation and evolution of relatively massive stars initiated at the shock, it is shown that the possible locations of the regions of luminous, newly born stars and the H II regions lie on the inner side of each observable gaseous spiral arm of H I, extending from the sharp H I peak at the shock on the inner edge to approximately the center of the arm, in general agreement with observations. (auth)

1230 SURVEY OF CURRENT PROBLEMS IN EXTRAGALACTIC ASTRONOMY. Burbidge, E. M. (Univ. of California, San Diego). pp 347-57 of Contemporary Physics: Trieste Symposium 1968. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.1); CONF-680629(Vol.1).

Topics covered include: (1) Major constituents of the extragalactic Universe; (2) Normal galaxies (physical properties and current problems) including masses, mass-to-light ratio, spiral arms, and evolution; (3) Nuclei—radio galaxies; and (4) Compact galaxies. (auth)

1231 RADIO STUDIES OF GALACTIC STRUCTURE. Burke, B. F. (Massachusetts Inst. of Tech., Cambridge). pp 401-16 of Contemporary Physics: Trieste Symposium 1968. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.1); CONF-680629(Vol.1).

Topics considered include galactic dynamics, spiral structure, and the anomalous motions. (auth)

1232 THE MAGNETIC FIELD OF THE GALAXY. Smith, F. G. (Nuffield Radio Astronomy Lab., Cheshire, Eng.). pp 417-21 of Contemporary Physics: Trieste Symposium 1968. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.1); CONF-680629(Vol.1).

Topics discussed include general evidence, optical evidence, galactic radio emission, polarized galactic emission, Faraday rotation from extragalactic sources, Zeeman splitting, Faraday rotation from Pulsar CP ρ950, a possible reconciliation, and small-scale irregularities. (auth)

1233 STELLAR POPULATIONS AND THE EVOLUTION OF THE GALAXY. Kraft, R. P. (Univ. of California, Santa Cruz). pp 449-57 of Contemporary Physics: Trieste Symposium 1968. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.1); CONF-680629(Vol.1).

The author, in discussing the evolution of the Galaxy, refers to the work of Baade and the questions of metal and He abundance. (auth)

1234 RADIO GALAXIES AND QUASARS. Smith, F. G. (Nuffield Radio Astronomy Lab., Cheshire, Eng.). pp 459-65 of Contemporary Physics: Trieste Symposium 1968. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.1); CONF-680629(Vol.1).

Topics considered in this review include the log N—log S relation, identifications, empty fields, special populations of radio sources, common properties of quasars and radio galaxies, angular sizes, and cosmological puzzles. (auth)

1235 EFFECTS OF VELOCITY DISPERSION ON THE EVOLUTION OF A DISK OF STARS. Hockney, R. W.; Hohl, Frank (Langley Research Center, Hampton, Va.). Astron. J., 74: 1102-4(Nov. 1969).

A computer model of a thin-disk galaxy has been used to study the stabilizing effect of velocity dispersion on the evolution of a disk galaxy. The motion of 50,000 model stars are computed stepwise in time as they move in their mutual gravitational fields. A cold balanced disk is found to be violently unstable. A velocity dispersion of 27% of the velocity at the edge of the disk stabilizes the system. These results agree with the theoretical predictions of Toomre. (auth)

1236 SHAPE OF THE GALACTIC SPIRAL ARMS AND PARAMETERS OF GALACTIC ROTATION, DETERMINED FROM OBSERVATIONS OF H II REGIONS. Courtes, G.; Georgelin, Y. P.; Georgelin, Y. M.; Monnet, G. (CNRS, Marseille). Astrophys. Lett., 4: 129-36(Oct. 1969).

It is shown that radial velocities and spectrophotometric distances for H II regions can be used as a link between galactic velocities determined from the λ21-cm line and the geometrical structure of the galactic arms as traced out by OB stars. The kinematic data from the interstellar matter (ionized hydrogen) and from the young stars (OB and Cepheids) are the same, which indicates the predominance of gravitational forces. In the longitude range $l^{II} = 305$ to 333°, two maxima of velocities are found, and two arms are observed as clearly separated as the well-known Perseus arm and the local arm. Neutral hydrogen, H II regions, young clusters, and O stars in the vicinity of the Sun are located in four spiral arms. Those arms are separated by distances of about 2 kpc and their pitch angle is about 20°. The morphological type of the Galaxy is discussed from these new data and it is found that the Galaxy seems to be similar to a multi-arm Sc galaxy (de Vaucouleurs' type SAB (rs) cd). From these observations new galactic constants are also derived. (auth)

1237 PHOTOGRAPHY OF THE FAINT OUTER REGIONS OF GALAXIES. Van Den Bergh, S. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. Lett., 4: 117-19(Oct. 1969).

Experimental use of Kodak IIIaJ emulsion behind filters which reduce the sky brightness is described. New data are given on M 51 and on the Seyfert galaxy NGC 4151. (auth)

1238 ZWICKY'S CORONA BOREALIS CLUSTER COUNTS. Noonan, Thomas W. (State Coll., Brockport, N. Y.). Astron. J., 74: 1105-7(Nov. 1969).

A method for making allowance for an inhomogeneous background in galaxy—cluster counts is suggested and applied to a particular cluster. Zwicky's counts of galaxies within rings centered on the Corona Borealis Cluster indicate the presence of 225 cluster members within a radius of about 30′ to the limit of the 18-inch Schmidt telescope ($m_{pg} \approx 19.2$), and of 850 members within a radius of about 50′ to the 48-inch Schmidt limit ($m_{pg} \approx 21.4$). There is a pronounced tendency for the brighter members to concentrate toward the cluster center. (auth)

Cosmology

Refer also to abstracts 1307, 1528, 1558, and 1659.

1239 X-RAY BACKGROUND IN ISOTROPIC WORLD MODELS. Payne, A. D. (Tasmania Univ., Hobart, Australia). Aust. J. Phys., 22: 521-35(Aug. 1969).

This paper is an attempt to describe the diffuse x-ray background in terms of Compton radiation from cosmic-ray electrons in intergalactic space. Similarities between the x-ray and radio-source spectra suggest that fast electrons escape more or less freely from the radio galaxies. It is assumed that the time scale of electron injection is small compared with the characteristic time of evolution of the Universe. The electrons are considered to lose energy through Compton scattering (due to the presence of the universal black-body radiation at 3°K) and by expansion of the coordinate system. A least squares fit of the derived spectra to the experimental x-ray spectrum provides useful information on the epoch at which electron injection commences. Normalization requires either nonequilibrium condi-

tions to exist within radio sources or the number of sources in unit coordinate volume to be a strong function of epoch. The results are consistent with a Universe in a state of rapid expansion. (Australia)

1240 ON THE HYPOTHESIS THAT THE EXPANSION OF THE UNIVERSE IS DUE TO A DISTRIBUTION OF NEUTRINOS OF SUFFICIENTLY HIGH DENSITY AND ON THE GRAVITATIONAL REDSHIFT. Wataghin, Gleb. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 45: 45-9(July-Aug. 1968).

A model of expanding, spatially homogeneous, and isotropic Universe of finite three-dimensional volume was studied from a partially new point of view. The integration of Einstein's gravitational equations, with the cosmological constant $\Lambda > 0$, leads to an interpretation of the Hubble effect which has not been considered before. (W.D.M.)

1241 COSMOLOGICAL CONSTANT IN A CLOSED UNIVERSE. Agnese, Angelo. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 45: 50-3(July-Aug. 1968).

It is shown that the value $\lambda = 0$ in a relativistic closed Universe model is not compatible with the available observational data, both in the case of λ matter Universe and in the case of a radiation Universe. (W.D.M.)

1242 CONSERVATION LAWS IN GENERAL RELATIVITY AND IN THE POST-NEWTONIAN APPROXIMATIONS. Chandrasekhar, S. (Univ. of Chicago). Astrophys. J., 158: 45-54 (Oct. 1969).

It is shown how the exact conservation laws of general relativity, expressed in terms of the symmetric energy–momentum complex of Landau and Lifshitz, can be used to determine the various conserved quantities in the different post-Newtonian approximations. Particular attention is given to the conserved energy which emerges as the integral over the whole of space of the difference between the (0,0)-component of the Landau–Lifshitz complex and the energy of the conserved mass present. The method is illustrated in the framework of the first post-Newtonian equations of hydrodynamics. (auth)

1243 LEMAITRE UNIVERSE, GALAXY FORMATION, AND OBSERVATIONS. Brecher, Kenneth (Massachusetts Inst. of Tech., Cambridge); Silk, Joseph. Astrophys. J., 158: 91-102 (Oct. 1969).

Several properties of the Lemaître universe are discussed. The possible growth of inhomogeneities from statistical fluctuations and the effect of galaxy formation on the stability of the quasi-static epoch are considered. It is concluded that the duration of the quasi-static epoch must be less than about 10^{11} years; otherwise, galaxy formation will induce a catastrophic collapse back to the initial singularity. Limits are derived on the redshift z_s at which the quasi-static epoch can occur and also on average cosmic-ray and electromagnetic fluxes produced following galaxy formation. The existence of an isotropic absorption feature at $1420/(1 + z_s)$ MHz is predicted. (auth)

1244 SUPERCLUSTERS OF GALAXIES. Yu, J. T. (Goddard Inst. for Space Studies, New York); Peebles, P. J. E. Astrophys. J., 158: 103-13(Oct. 1969)

The distribution in the sky of the "rich," "compact" clusters of galaxies was analyzed, by means of a new statistical approach, in an attempt to find an independent test of the existence of superclusters in these data. Results suggest that any tendency toward superclustering is scarcely above that to be expected for a random distribution. On the other hand, the results cannot rule out the existence of some superclusters. If there exist superclusters of the kind proposed by Abell, an upper limit of 10% can be placed on the possible fraction of the great clusters that might be found in such superclusters. (auth)

1245 THE SECOND POST-NEWTONIAN EQUATIONS OF HYDRODYNAMICS IN GENERAL RELATIVITY. Chandrasekhar, S.; Nutku, Yavuz (Univ. of Chicago). Astrophys. J., 158: 55-79 (Oct. 1969).

The equations of hydrodynamics governing a perfect fluid in the second post-Newtonian approximation to general relativity are derived; in this approximation all terms inclusive of $O(c^{-4})$ are retained consistently with Einstein's field equations. And the equation $T^{ij}_{;j} = 0$ governing the energy-momentum tensor is also derived to $O(c^{-4})$. The various conserved quantities to $O(c^{-4})$ are isolated with the aid of the Landau–Lifshitz complex Θ^{ij}. In particular, to obtain the conserved energy to $O(c^{-4})$ it is necessary to evaluate the metric coefficient $g_{\alpha\beta}$ to $O(c^{-6})$, i.e., to an order appropriate to the third post-Newtonian approximation. (auth)

1246 POST-NEWTONIAN n-BODY EQUATIONS OF THE BRANS-DICKE THEORY. Estabrook, Frank B. (California Inst. of Tech., Pasadena). Astrophys. J., 158: 81-3(Oct. 1969).

The post-Newtonian equations of the Brans–Dicke scalar–tensor theory are derived, for the case of n gravitating point masses. They are a set of coupled second-order differential equations for the accelerations of the point masses, which prove to be derivable from a classical velocity-dependent Lagrangian. (auth)

1247 COSMOLOGICAL CONSEQUENCES OF A CHARGE EXCESS. Dolan, Patrick (Imperial Coll. of Science and Tech., London). Compt. Rend., Ser. A, 268: 1507-8(June 16, 1969). (In French).

Using the Newtonian cosmology of Milne–McCrea, a simple presentation of the ideas of Lyttleton and Bondi on the electric Universe is given. The equalized Universe, according to this presentation, is a fluid of hydrogen atoms, distributed homogeneously and isotropically. The charge excess borne by each hydrogen atom gives rise to a universal repulsive force. The Universe appears isotropic to each observer. Various relations are given and discussed for this Universe. (J.F.P.)

1248 SUPERFLUIDITY AND SUPERCONDUCTIVITY IN THE UNIVERSE. Ginzburg, V. L. (Lebedev Inst. of Physics, Moscow). J. Statist. Phys., 1: 3-24(1969).

The current status of the problem concerning the existence and observation of superfluid and superconducting states in the universe, that is, under cosmic conditions, is discussed. Following an introduction, Bose–Einstein condensation, superfluidity, and superconductivity; possibilities for the occurrence of superfluidity and superconductivity under cosmic conditions; superconductivity of dense, degenerate electron plasma (large planets, white dwarfs); superfluidity and superconductivity in neutron stars; and finally superfluidity in a cosmological neutrino "sea" are discussed. (auth)

1249 THEORETICAL IMPLICATIONS OF THE KNOWN FACTS ABOUT GRAVITATION. Thirring, W. (Univ. of Vienna). pp 485-7 of Contemporary Physics: Trieste Symposium 1968. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.1); CONF-680629(Vol.1).

The empirical facts known about gravitation are classified, and the properties of gravitational theory proved by them are discussed. (auth)

1250 RECENT DEVELOPMENTS IN OBSERVATIONAL COSMOLOGY. Sciama, D. W. (Cambridge Univ., Eng.). pp 489-95 of Contemporary Physics: Trieste Symposium 1968. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.1); CONF-680629(Vol.1).

Recent developments in observational cosmology are discussed in terms of radio sources; helium; x-ray background; and the existence, origin, effects, and isotropy of the excess microwave background. (W.D.M.)

1251 OBSERVATIONAL COSMOLOGY: OPTICAL WAVELENGTHS. Burbidge, E. M. (Univ. of California, San Diego). pp 497-505 of Contemporary Physics: Trieste Symposium 1968. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.1); CONF-680629(Vol.1).

The Hubble relation is considered including cosmological models, results, and observational problems. A brief discussion on quasars and their place in the cosmological scheme is given. (W.D.M.)

1252 REMARKS ON GRAVITATION AND COSMOLOGY. Dicke, R. H. (Palmer Physical Lab., Princeton, N. J.). pp 507-10 of Contemporary Physics: Trieste Symposium 1968. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.1); CONF-680629(Vol.1).

In discussing a relation between stellar evolutionary ages and gravitational theory, the author makes reference to the scalar-tensor theory and the technique of dating by the radioactive decay of uranium. (auth)

1253 REMARKS ON THE GENERAL PRINCIPLES OF EINSTEIN'S GRAVITATION THEORY. Fock, V. (Leningrad State Univ.). pp 511-13 of Contemporary Physics: Trieste Symposium 1968. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.1); CONF-680629(Vol.1).

The author discusses some of the ambiguities that arise, and comments on some of the terms. (auth)

1254 GENERAL RELATIVITY: SURVEY AND EXPERIMENTAL TESTS. Dicke, R. H. (Palmer Physical Lab., Princeton, N. J.). pp 515-31 of Contemporary Physics: Trieste Symposium 1968. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.1); CONF-680629(Vol.1).

Topics covered by this review include field theories of gravitation, the null experiments, the famous three tests, and the solar gravitational quadrupole moment. (auth)

1255 GENERAL RELATIVITY THEORY AND EXPERIMENTS. Weber, J. (Univ. of Maryland, College Park). pp 533-8 of Contemporary Physics: Trieste Symposium 1968. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.1); CONF-680629(Vol.1).

An attempt is made to defend Einstein's general theory of relativity in the light of Dicke's recent criticisms. The authors program of development of apparatus and search for gravitational radiation is discussed breifly. (W.D.M.)

1256 QUANTIZATION OF THE GRAVITATIONAL FIELD. Dirac, P. A. M. (Cambridge Univ., Eng.). pp 539-43 of Contemporary Physics: Trieste Symposium 1968. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.1); CONF-680629(Vol.1).

Topics discussed include classical rules for constraints, quantum rules for constraints, constraints for the classical gravitational field, and the quantization problem. (auth)

1257 GRAVITATIONAL COLLAPSE. Penrose, R. (Birkbeck Coll., London). pp 545-56 of Contemporary Physics: Trieste Symposium 1968. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.1); CONF-680629(Vol.1).

The gravitational collapse of a spherically symmetric body, to within its Schwarzschild radius, is discussed in qualitative terms. The concept of a "trapped surface" is presented, in order to deal with asymmetric cases. The effect of rotation is illustrated by reference to the Kerr solution. Two cases, namely of "small" and "large" angular momentum, are contrasted. In the latter case no trapped surface (and no event horizon) arises. A new theorem, due jointly to Hawking and the present author, is described, which effectively incorporates and generalizes the previous theorems predicting space–time singularities. In particular, if a physically acceptable space–time contains a trapped surface (or, alternatively, if it is spatially closed), then on the basis of Einstein's equations (with $\lambda = 0$), it must possess a singularity. (auth)

1258 SINGULARITY IN THE GENERAL SOLUTION OF THE GRAVITATIONAL EQUATIONS. Lifshitz, E. M. (Inst. for Theoretical Physics, Moscow). pp 557-8 of Contemporary Physics: Trieste Symposium 1968. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.1); CONF-680629(Vol.1).

The problem of the existence of a singularity in the general solution of the gravitational equations is of great importance for relativistic cosmology, the more nearly it can be stated in a precise form in the framework of general relativity. (W.D.M.)

1259 REMARKS ON GRAVITATIONAL RADIATION. Weinberg, S. (Massachusetts Inst. of Tech., Cambridge. Univ. of California, Berkeley). pp 559-61 of Contemporary Physics: Trieste Symposium 1968. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.1); CONF-680629(Vol.1).

The author discusses gravitational radiation and makes some observations about soft gravitons. (auth)

1260 HAMILTONIAN DYNAMICS AND POSITIVE ENERGY IN GENERAL RELATIVITY. Deser, S. (Brandeis Univ., Waltham, Mass.). pp 563-9 of Contemporary Physics: Trieste Symposium 1968. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.1); CONF-680629(Vol.1).

A review is first given of the Hamiltonian formulation of general relativity; the gravitational field is a self-interacting massless spin-two system within the framework of ordinary Lorentz covariant field theory. The recently solved problem of positive-definiteness of the field energy is then discussed. The latter, a conserved functional of the dynamical variables, is shown to have only one extremum, a local minimum, which is the vacuum state (flat space). This implies positive energy for the field, with the vacuum as ground-state. Similar results hold when minimally coupled matter is present. (auth)

1261 BEYOND THE MILKY WAY: GALAXIES, QUASARS, AND THE NEW COSMOLOGY. Page, Thornton; Page, Lou Williams (eds.). Macmillan Sky and Telescope Library of Astronomy. Volume 8. New York, The Macmillan Company, 1969. 350p. $7.95.

A collection of reprints from Sky and telescope on extragalactic astronomy is presented. The reprints cover the period starting 40 years ago, most of the papers being recent. (W.D.M.)

Planetary Phenomena

1262 IO-RELATED POLARIZATION CHARACTERISTICS OF THE JOVIAN DECAMETER EMISSION. Green, Terry C.; Sherrill, William M. (Southwest Research Inst., San Antonio). Astrophys. J., 158: 351-63(Oct. 1969).

Measurements of the polarization of the decameter radiation from Jupiter at 15 to 24 MHz were made during the 1966–1967 apparition and combined with data from the 1963–1964 apparitions for analysis. Polarization data analyzed in terms of Io departure angle from superior geocentric conjunction showed axial-ratio profiles consistent with the Dulk model of the Jovian source and also with previously observed polarization characteristics reported as a function of System III longitude. Comparison of the Southwest Research Institute (SwRI) data with cyclotron-model predictions and the recently reported data from Florida State University shows the SwRI burst distribution above 16 MHz to be more circular than that reported by Barrow or predicted by the cyclotron model. The inclusion in the analyses at SwRI of an intensity-selection effect favoring more intense bursts than those analyzed at Florida State University is the simplest suggestion to explain the difference in results. Other cyclotron-model predictions, however, involving the uniformity of emitted polarization are in good agreement with the SwRI data. (auth)

Atomic and Molecular Physics

Refer also to abstracts 1499 and 1088.

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstracts 706, 1468, and 1703.

1263 (NP-18046) AN ANALYTICAL STUDY OF THE PRODUCTS OF COLLISIONS OF 1 eV ATOMS WITH CONTAMINATED SURFACES. Report No. 69-53. Chiang, Kuang-Chi (California Univ., Los Angeles. School of Engineering and Applied Science). Sept. 1969. 110p.

A simple classical model of interactions between incident gas molecules and a contaminated surface is proposed. If the energy of the beam particles is sufficiently high, say 1 to 10 eV, then adsorbed particles can be dislodged during these interactions. Calculations indicate that, if the adsorption potential varies periodically along the surface, the adsorbed particles are sputtered into a multilobular distribution. The positions of the peaks depend on the velocity of the incident particles, the heat of adsorption, the amplitude of the adsorption-potential variation, and the equilibrium adatom-surface distance. For a relatively clean surface, the scattering distributions are nearly diffuse with a prominence in the forward direction. Calculation results for an argon beam impinging on mica and silver surfaces contaminated with water vapor agree qualitatively with pertinent experimental results. Hence the present model provides a possible explanation for the observed multilobular scattering distributions. (auth)

1264 COEFFICIENT OF BACKSCATTERING IN THE CASE OF MONOENERGETIC ELECTRONS ARRIVING AT THE TARGET WITH AN OBLIQUE INCIDENCE. Arnal, Floreal; Verdier, Pierre; Vincensini, Paul-Dominique (CNRS, Toulouse). Compt. Rend., Ser. B, 268: 1526-9(June 9, 1969). (In French).

The coefficient of backscattering from solid samples bombarded at oblique incidence by a parallel beam of monoenergetic electrons

is obtained simply, starting from relations that define the transmission of electrons through thin sheets of material. The agreement between the theoretical and experimental values appears satisfactory. (tr-auth)

1265 PHOTOIONIZATION OF HEAVY ATOMS: THEORETICAL STUDY IN NONRELATIVISTIC MODEL WITH A CENTRAL POTENTIAL. Combet Farnoux, Francoise (Faculte des Sciences de Paris, Orsay, France). J. Phys. (Paris), 30: 521-30(July 1969). (In French).

Calculations of photo-ionization cross sections for subshells 4d, 4f, 5p, 5d, 5f, 6p in heavy atoms (atomic number $Z \geq 71$) were performed using a one-electron and nonrelativistic model with a central potential. This work shows that subshells are responsible for important variations shown by photoabsorption measurements in the ultrasoft-x-ray range (far from absorption edges) for various heavy atoms. In addition, it predicts the manner in which the contribution of these various subshells is dependent on Z and photon energy (varying between the limits of vacuum ultraviolet and soft-x-ray ranges), and it explains why the variations of cross sections are more important for external subshells than for inner shells of same l, although the potential used in the calculations is the same for all the electrons. (auth)

1266 INTERACTION OF He^+ IONS WITH CERTAIN METALS. Vyat-skin, A. Ya.; Alekseev, V. V.; Makarov, K. A. (Inst. of Precision Mechanics and Optics, Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 408-12(Sept. 1969).
Translated from Zh. Tekh. Fiz., 39: 549-53(Mar. 1969).

Results are given for a study of the transmission, reflection, and absorption coefficients for He^+ ions in thin, free films of Al, Cu, and Ag as functions of the initial energy, thickness, and atomic number of the material. The initial energy of the He^+ ions was 3 to 30 keV. The vacuum in the sample chamber was $\sim 8 \times 10^{-8}$ torr with inflow of gas to the ion source. The sample chamber was pumped down with oil-free pumps. Necessary steps were taken to suppress secondary ion–electron and ion–ion emission. It was established that the coefficients mentioned were interrelated. The dependence of the transmission coefficient η on film thickness x for He^+ ions and for the metals investigated can be expressed by the empirical equation $\eta = \exp(-\alpha x^p)$, where $\alpha = \alpha(E_0, Z)$ and $p = p(Z)$. (auth)

1267 INVESTIGATION OF TRANSMISSION, REFLECTION, AND ABSORPTION OF He^+ IONS IN THIN SEMICONDUCTOR FILMS. Vyat-skin, A. Ya.; Makarov, K. A.; Alekseev, V. V. (Inst. of Precision Mechanics and Optics, Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 413-16(Sept. 1969).
Translated from Zh. Tekh. Fiz., 39: 554-7(Mar. 1969).

The results are given of a combined determination of the coefficients of transmission, absorption, and reflection of He^+ ions in thin Si and Ge films as functions of the initial energy, the film thickness, and the atomic number of the material. The initial energy of the He^+ ions was 3 to 30 keV and the film thickness was 460 to 2010 Å. The apparatus was evacuated with oil-free pumps. The vacuum in the sample chamber after admission of gas into the ion source was $\approx 8 \times 10^{-8}$ torr. Measures were taken to suppress secondary ion–electron and ion–ion emission. It was established that the above coefficients are related. An empirical equation was found for the dependence of the transmission coefficient η on the thickness x: $\eta = \exp(-\alpha x^p)$ [where $\alpha = \alpha(E_0, Z)$ and $p = p(Z)$], which holds for thin films of a solid body (metals or semiconductors). (auth)

Atomic and Molecular Properties

Refer also to abstracts 1139, 1173, 1392–1295, and 1407.

1268 ABSORPTION SPECTRA OF Yb I. Camus, Pierre; Tomkins, Frank S. (Argonne National Lab., Ill.). J. Phys. (Paris), 30: 545-50(July 1969). (In French).

Seventy-three absorption lines of ytterbium were measured in the ultraviolet region between 1980 and 2300 Å. The lines are interpreted as being transitions between the ground level $6s^2\ ^1S_0$ and the $^1P_1$ and $^3P_1$ levels of the excited configuration 6s np of Yb I. Examination of the Rydberg series $6s^2\ ^1S_0 \rightarrow 6s\ np^1P_1$, for n varying from 6 to 48, gives the value 50,441.0 ± 0.2 cm^{-1} for the limit, which is the ground state $6s\ ^2S_{\frac{1}{2}}$ of Yb II. The ionization potential of Yb I is thus 6.2537 ± 0.0002 volts; the precision is limited by the determination of the conversion factor 8,065.73 ± 0.23 cm^{-1}/eV. (auth)

1269 DESCRIPTION OF A NEW METHOD OF MEASURING THE HYPERFINE STRUCTURE OF EXCITED ATOMIC LEVELS: APPLICATION TO CERTAIN LEVELS ^1D OF ^3He. Pavlovic, Milica; Laloe, Franck (CNRS, Paris). Compt. Rend., Ser. B, 268: 1485-8(June 9, 1969). (In French).

Various excited levels of ^3He in a discharge are oriented and aligned, starting from a nuclear orientation in the ground state. The orientation and alignment thus obtained vary as a function of the applied static magnetic field; the study of these variations leads to a new method of measuring the hyperfine structure of excited atomic levels. This method applied to several ^1D levels of ^3He, gives results in good agreement with those from transverse electron-bombardment experiments. (tr-auth)

1270 PERMANENT ELECTRIC DIPOLE MOMENT OF THE CESIUM ATOM. AN UPPER LIMIT TO THE ELECTRIC DIPOLE MOMENT OF THE ELECTRON. Stein, T. S.; Carrico, J. P.; Lipworth, E.; Weisskopf, M. C. (Brandeis Univ., Waltham, Mass.). Phys. Rev., 186: 39-57(Oct. 5, 1969).

An atomic-beam magnetic-resonance apparatus has been employed to search for a linear Stark effect on the flop-in Zeeman transition ($F = 4, m_F = -4$) ↔ ($F = 4, m_F = -3$) of the ground state of the cesium atom. Such an effect could be interpreted in terms of a permanent electric dipole moment (EDM) of the cesium atom. The existence of an EDM in a nondegenerate physical system having well-defined angular momentum, such as the cesium atom in its ground state, would be direct evidence of a violation of parity and time-reversal invariance. To detect a possible linear Stark effect, a voltage of 10 kV is applied across two parallel metal plates located between the rf loops of a Ramsey double-hairpin structure. A beam of cesium atoms passes between the metal plates, where it is subjected to an electric field of approximately 5×10^4 V/cm. The flop-in Zeeman transition is observed for a magnetic field of 0.95 G. The signal generator that drives the rf loops is adjusted so that the detector signal corresponds to the point of maximum slope on one side of the central peak of the two-loop interference pattern. The direction of the electric field is reversed every 0.57 sec, and the resonance signal is accumulated in two counters (one for each direction of the electric field), gated synchronously with the electric-field switching frequency. Thus, the quadratic Stark effect contributes the same signal to each counter, and a difference between the counters indicates the presence of a resonance shift linear in E. With the apparatus used in the present experiments, resonance shifts as small as 2 or 3 parts in 10^6 of the linewidth (850 cps in cesium) could be observed with about 2 hr of integration time. A linear resonance shift that simulates a linear Stark effect can be caused by the interaction between the atom's magnetic dipole moment and the magnetic field $[(\vec{v}/c) \times \vec{E}]$ due to the atom's motion through $\vec{E}$. To separate this motional magnetic-field effect from a possible linear Stark effect, the resonance shift linear in E is studied as a function of the angle between $\vec{E}$ and $\vec{H}$, and the angles corresponding to zero resonance shift are obtained in sodium and cesium. A difference between these angles for sodium and cesium would indicate the presence of a linear effect other than $\vec{v} \times \vec{E}$. The magnitude of this difference can be used to set an upper limit on the linear Stark effect in cesium. A relativistic argument shows that if the electron possesses an EDM, the EDM of the Cs atom is approximately 119 times as large, whereas that of the sodium atom is 0.3 times as large. These results, together with the measured values of the angles that correspond to zero resonance shifts in Na and Cs, lead to the following upper limits on the EDM's of the Cs atom and the free electron: $\mu_{Cs}/e < 3 \times 10^{-21}$ cm and $\mu_e/e < 2.5 \times 10^{-23}$ cm. (auth)

1271 THE ORIGIN OF HIGH-FREQUENCY SATELLITES α^x AND α' IN THE L-EMISSION SPECTRA OF RARE EARTHS. Kapoor, Q. S. (Banaras Hindu Univ., India); Garg, K. B.; Nigam, A. N. Phys. Lett., 30A: 228-9(Oct. 20, 1969).

The origin of $L\alpha^x$ and $L\alpha'$ satellites in the x-ray spectra of rare earths has been explained on the double ionization theory as follows: $L\alpha^x$, $L_{II}M_I \rightarrow M_IM_V$; and $L\alpha'$, $L_{III}M_{III} \rightarrow M_{III}M_V$. The calculated wavelengths of the lines match with the experimental ones. (auth)

1272 LIFETIMES OF SOME Fe I STATES BY BEAM-FOIL SPECTROSCOPY. Whaling, Ward; King, Robert B.; Martinez-Garcia, Mario (California Inst. of Tech., Pasadena). Astrophys. J., 158: 389-98(Oct. 1969).

The light emitted by 500-keV Fe atoms excited by passage through a thin carbon foil was analyzed spectroscopically to identify fifty known transitions in Fe I. The light decay downstream from the foil was measured to find the lifetime of six levels in Fe I between 48 and 57 kK. The lifetimes are longer from 4.5 at 48 kK to 21 at 57 kK. The dependence of this factor on excitation energy raises doubt about the level population assumed by Corliss and Tech in interpreting the relative line intensities from the arc source. (auth)

1273 EVALUATION OF THE LAMB SHIFT FOR THE HYDROGEN MOLECULE-ION. Gersten, Joel I. (Bell Telephone

Labs., Inc., Murray Hill, N. J.). J. Chem. Phys., 51: 3181-5 (Oct. 15, 1969).

The Lamb shift of the hydrogen molecular ions H_2^+ and HD^+ was calculated to the lowest order in the radiative corrections. It is found to depend sensitively on internuclear separation and therefore to shift the various vibrational levels by a different amount. Possible experimental tests are considered for the detection of these quantum electrodynamical effects. (auth)

Positronium, Muonium, and Mesic Atoms and Molecules

1274 FIZICHESKAYA KHIMIYA POZITRONA I POZITRONIYA. (Physical Chemistry of Positrons and Positronium). Gol'danskii, V. I. Moscow, Izdatel'stvo Nauka, 1968. 175p.

Uses of positron annihilation in studies of physical and chemical properties of materials are reviewed briefly. General properties of positrons, their retardation in matter, and processes involved in formation and destruction of the simplest hydrogen-like atom (positronium) are described. Basic experimental methods used in observation of positron annihilation are analyzed. Pick-off annihilation, positron annihilation in collisions with quasi-free electrons, angular correlation of annihilation γ quanta, and bound states of positrons in atomic, molecular, and ionic systems are discussed. (R.V.J.)

1275 LIFETIME MEASUREMENT OF POSITRONIUM IN ^{22}Na BY DELAYED COINCIDENCE METHOD. Tung, K. N. (Inst. of Nuclear Energy Research Atomic Energy Council, [Taiwan]); Tang, M. D. Ho Tsu K'o Hsueh, 6: No. 3-4, 39-45(Apr. 1969).

The lifetime of positronium in ^{22}Na was measured as $(1.39 \pm 0.34) \times 10^{-10}$ sec by a delayed coincidence method. (auth)

1276 USE OF POSITRONIUM IN EVALUATING POLYMER PROPERTIES. Khan, M. N. G. A. (Atomic Energy Centre, Dacca, Pakistan). Proc. Roy. Aust. Chem. Inst., 36: 246-8(Aug. 1969).

The principles of positronium formation and annihilation are outlined. Some developments in experimental studies of the crystallinity, polarity, phase transitions, degradation, and irradiation of solid polymers are mentioned briefly. (Australia)

1277 RADIATION DAMAGE DEPENDENCE OF POSITRON LIFETIMES IN SODIUM HALIDE CRYSTALS. Williams, Thomas L.; Ache, Hans J. (Virginia Polytechnic Inst., Blacksburg). J. Chem. Phys., 51: 3536-9(Oct. 15, 1969).

Positron lifetime spectra in NaCl and NaF single crystals were measured and analyzed as a function of the crystal defect concentration introduced by proton and gamma irradiation. In the irradiated sodium chloride samples a long-lived component was observed with a lifetime (τ_B) of 8.2×10^{-10} sec and an intensity (I_B) of up to 28%. Thermal annealing of the sample caused a drastic reduction of the intensity of this component (I_B) to about 10%. Similar observations were made in the positron lifetime spectra in the NaF system. (auth)

1278 ANGULAR CORRELATION OF POSITRON-ANNIHILATION RADIATION FROM CERIUM HYDRIDE. Chouinard, M. P. (Wayne State Univ., Detroit); Gustafson, D. R.; Heckman, R. C. J. Chem. Phys., 51: 3554-8(Oct. 15, 1969).

The angular correlation of positron-annihilation radiation from cerium hydride was measured for hydrogen concentrations in the range H/Ce = 1.8 to 2.6. The angular correlations were found to be broader than that from cerium metal and to increase in width with increasing hydrogen concentration in a manner consistent with the screened protonic model of the electronic structure. The anionic model does not provide a satisfactory explanation of the measured angular correlations. (auth)

Collision Phenomena

1279 SCATTERING OF ELECTRONS FROM H_2^+. [PART] II. Temkin, A.; Vasavada, K. V.; Chang, Edward S.; Silver, A. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev., 186: 57-66(Oct. 5, 1969).

A previous analysis of electron scattering from diatomic molecular systems in spherical coordinates is generalized to include the coupling of different partial waves in the fixed-nuclei approximation. The factorability between dynamical parameters and those depending on internuclear-axis orientation can be maintained, and the optical theorem is shown to hold for all orientations of the internuclear axis in certain classes of approximations. The method of polarized single-center orbitals is extended to d-wave $e-H_2^+$ scattering both with and without coupling to s waves. The d-wave phase shifts are sizable; the effect of the coupling on the s and d waves and on the angular distributions is found to be nonnegligible. Some comments on quantum-defect extrapolations are made. (auth)

1280 PRESSURE SHIFTS OF HIGH-SERIES SPECTRAL LINES AND CROSS SECTIONS FOR SCATTERING OF VERY SLOW ELECTRONS FROM RARE-GAS ATOMS. Choudhury, M. H. (Univ. of Hull, Eng.). Phys. Rev., 186: 66-82(Oct. 5, 1969).

A completely quantum-mechanical theory of the pressure shift of high-series spectral lines of alkali atoms by foreign gases (usually inert gases) is presented. In this version of the theory, the Schrödinger equation for the whole system consisting of the excited alkali atom and the foreign gas is written, the interaction terms simplified, and the resulting equation solved by the methods of perturbation theory. The main qualitative results of Fermi's theory are reproduced, together with contributions from other terms that have no analog in Fermi's theory, and whose interpretation leads to interesting physical consequences justified by experimental observations. In particular, values of the total cross section for the scattering of very slow electrons at effective electron kinetic energies between 0.034 and 0.21 eV are obtained, and found to be in fair agreement with those obtained directly from experiment. For argon, krypton, and xenon, these results indicate the existence of the Ramsauer–Townsend effect. (auth)

1281 EVALUATION OF ELECTRON–ATOM BREMSSTRAHLUNG FROM ELASTIC SCATTERING. Mjolsness, R. C. (Pennsylvania State Univ., University Park); Ruppel, Hans M. Phys. Rev., 186: 83-8(Oct. 5, 1969).

Asymptotic wave functions together with a perturbation-theoretic treatment of the long-range polarization effects are used to provide an analytic expression for the dipole-length matrix element for electron–neutral-atom bremsstrahlung. This result permits the evaluation of bremsstrahlung from elastic scattering phase shifts at the initial and final electron energy and from the static polarizability of the atom. The expression is approximate and contains a weak dependence on a cutoff parameter, but it provides a complete generalization of the formulas due to Low and to Kas'yanov and Starostin, and it contains terms of all orders in the photon energy. The result is that, by substitution into the formulas, the bremsstrahlung cross section may be evaluated to within a few percent for nearly all the energy range tested, once the elastic scattering phase shifts have been determined. (auth)

1282 RESONANT CHARGE EXCHANGE OF THE NEGATIVE IONS IN SLOW COLLISIONS WITH ATOMS. Davidovic, D. M.; Janev, R. K. (Boris Kidric Inst. of Nuclear Science, Belgrade). Phys. Rev., 186: 89-95(Oct. 5, 1969).

The resonant single-charge-transfer process for negative ions, $A^- + A \rightarrow A + A^-$, is considered at low energies. The exact asymptotic behavior of the energy separation $\Delta(R)$ of the symmetrical and antisymmetrical states of the quasi molecule A_2^- is determined. In the adiabatic region, the transition probability of charge-exchange processes is determined by $\Delta(R)$. The general results are used to calculate cross sections for $A^- + A \rightarrow A + A^-$ reactions where A is H, Na, K, Rb, and Cs. Comparison is made with the experimental data and with the calculations of other authors. (auth)

1283 TOTAL CROSS SECTIONS FOR INELASTIC SCATTERING OF CHARGED PARTICLES BY ATOMS AND MOLECULES. III. ACCURATE BETHE CROSS SECTION FOR IONIZATION OF HELIUM. Inokuti, Mitio; Kim, Yong-ki (Argonne National Lab., Ill.). Phys. Rev., 186: 100-4(Oct. 5, 1969).

The Bethe cross section σ_i for ionization of He by fast charged particles is accurately evaluated by a subtraction $\sigma_i = \sigma_{tot} - \sigma_{ex}$, where σ_{tot} is the total inelastic scattering cross section and σ_{ex} is the sum of all discrete-excitation cross sections. Earlier work has given a highly precise value of σ_{tot}, and recent results on discrete excitations enable one to determine σ_{ex}. The resulting "counting" ionization cross section for a particle of charge ze and velocity $v = \beta c$ is

$$\sigma = \frac{8\pi a_0^2 z^2}{mv^2/R}\left\{0.489\left[\ln\left(\frac{\beta^2}{1-\beta^2}\right) - \beta^2\right] + 5.526\right\}$$

where m is the electron mass, a_0 is the Bohr radius, and R is the Rydberg energy. Among numerous measurements, the electron-impact data by Smith are most consistent with the present result and suggest a gradual attainment of the Bethe asymptotic behavior near 1-keV incident electron energy. (auth)

1284 COINCIDENCE METHOD FOR STUDYING CHARGE EXCHANGE IN PROTON–INERT GAS INTERACTIONS. Afrosimov, V. V.; Mamaev, Yu. A.; Panov, M. N.; Fedorenko, N. V.

(Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 109-14(July 1969).
Translated from Zh. Tekh. Fiz., 39: 159-65(Jan. 1969).

The cross sections for charge-exchange processes in collisions of protons with He, Ne, Kr, and Xe atoms were measured in the proton energy range 5 to 50 keV. The method of simultaneous determination of the charge of both atomic particles after the collision and coincidence counting, used earlier for the H^+–Ar pair, was used for the measurements. Processes that result in the formation of slow positive ions of helium with charge 1 or 2, neon with charges from 1 to 3, krypton and xenon with charges from 1 to 4, and fast protons having either their usual charge or converted into fast atoms or negative ions of hydrogen were studied. The data corroborate the result previously observed that in the formation of multiply charged slow ions the most important process is the capture of one electron by the proton and simultaneous ionization of the atom. Most capture and ionization cross sections in the heavier atoms (Kr and Xe) have a maximum in the proton energy range 20 to 40 keV, in spite of the significant energy expenditure required for such processes (up to ~100 eV). The cross sections for pure ionization processes generally increase monotonically with proton energy. However, in addition to pure ionization processes the relative probability for processes with the loss of several electrons for Ar, Kr, and Xe also have maxima in the 20 to 40 keV proton range. The data confirm the fact that at incident velocities near the velocity of the outer atomic electrons the interaction between the protons and the atoms differs qualitatively from the collisions at higher velocities. (auth)

1285 ON THE IMPACT OF PROTONS ON HYDROGEN ATOMS. III. THE PARAMETRIC TREATMENT APPLIED TO p,H COLLISIONS: ANALYTICAL ASPECTS. Fennema, J. W. R. (FOM-Instituut voor Atoom- en Molecuulfysica, Amsterdam). Physica, 44: 90-119(Sept. 8, 1969).

The parametric (or impact-parameter) method is used to derive the equations describing proton–hydrogen collisions in the energy range of 0.5 to 50 keV. Only the 1s, 2s, $2p_0$, $2p_{\pm1}$ states of the target and the (neutralized) projectile are accounted for. First the Schroedinger equation is replaced by a set of 10 simultaneous differential equations of the first order in the time. The coefficients form a (complex) matrix and are functions of the time; they are parametrically dependent on the impact parameter and the impact velocity. The evaluations of these coefficients are considered for near-adiabatic as well as for near-impulsive treatments. In case these coefficients combine electron states defined on different nuclei, a (single) numerical quadrature finally remains; often complex arithmetic is required. The differential equations possess several properties that may serve as criteria to test the correctness of the solution. They are the normalization of the probability amplitudes (the conservation of probability), the invariance with respect to an initial phase factor (connected with the irrelevance of the internuclear potential energy), the invariance with respect to the sign of the magnetic quantum number, and the symmetry because of the identity of the nuclei. The two last properties are also used to reduce the number of equations. (auth)

1286 EXCITATION OF HELIUM BY H_2^+ AND H_3^+ (1 TO 150 keV). Van Den Bos, J.; Winter, G.; De Heer, F. J. (FOM-Instituut voor Atoom- en Molecuulfysica, Amsterdam). Physica, 44: 143-60(Sept. 8, 1969).

Cross sections have been measured for excitation of helium to n^1S, n^1P, n^1D, n^3S, n^3P, and n^3D states (n = 3, 4, 5, 6) by 1- to 150-keV H_2^+ and H_3^+ ions. Comparison is made with previous experiments on singlet excitation of helium by protons. In a large velocity region the excitation cross section has a similar behavior for the three projectiles and often increases in the order of H^+, H_2^+, and H_3^+. Towards lower velocities H_2^+ and H_3^+ are much more effective in excitation than H^+, probably because of the possibility of exchange of electrons in the case of H_2^+ and H_3^+. In the energy region studied the cross section for triplet excitation is of the same order of magnitude as for singlet excitation, indicating the importance of exchange of electrons. (auth)

1287 SPIN CHANGE IN COLLISIONS OF HYDROGEN ATOMS. Allison, A. C.; Dalgarno, A. (Harvard Coll. Observatory, Cambridge, Mass. Smithsonian Astrophysical Observatory, Cambridge, Mass.). Astrophys. J., 158: 423-5(Oct. 1969).

Accurate calculations are presented of the cross sections for spin change in the collision of a pair of hydrogen atoms. (auth)

1288 EFFECT OF RECOIL ON THE VELOCITY DISTRIBUTION OF METASTABLE ATOMS PRODUCED BY ELECTRON IMPACT. Pearl, J. C.; Donnelly, D. P.; Zorn, J. C. (Univ. of Michigan, Ann Arbor). Phys. Lett., 30A: 145-7(Oct. 6, 1969).

It is shown both experimentally and by a simple kinematic argument that the velocity distribution in a beam of metastable atoms produced by electron bombardment of ground-state atoms deviates strongly from the velocity distribution of the ground-state atoms. (auth)

1289 MEAN CROSS SECTIONS FOR IONIZATION OF NEUTRAL BEAMS BY ELECTRONS WITH A MAXWELLIAN VELOCITY DISTRIBUTION. Alinovskii, N. I.; Nesterikhin, Yu. E.; Pakhtusov, B. K. Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 96-8 (July 1969).
Translated from Zh. Tekh. Fiz., 39: 139-42(Jan. 1969).

Numerical integration was used to find the mean values of the cross sections for ionization of accelerated beams of neutral particles (H, H_2, and He) by plasma electrons with a Maxwellian velocity distribution. Any directed velocity of the particles of the beam was taken into account in the calculations. For the determination of the effective ionization cross section of slower neutral particles of H, H_2, D_2, He, N_2, O_2, Ne, Kr, and Ar the mean values of the quantity $\langle\sigma_e\rangle$ were found. The values of the cross sections used in the calculations for the ionization of neutral particles by electron impact were obtained by averaging the experimental values of several authors. (auth)

1290 THE FANO–LICHTEN MODEL IN THE Ar^+–Ar COLLISIONS. Picca, D. (Univ., Bari, Italy). Nuovo Cim., 64B: 1-6(Nov. 11, 1969).

Collisions of Ar^+–Ar for energies in the range of 6 to 400 keV are analyzed according to the molecular model. A new scheme is presented, which differs from the Fano–Lichten model by an additional excitation of a 2s electron. In this way good agreement with experiment is obtained. (auth)

1291 COMMENT ON QUENCHING OF GLORY UNDULATIONS IN ATOM–MOLECULE SCATTERING. LeBreton, P. R.; Kramer, H. L. (Harvard Univ., Cambridge, Mass.). J. Chem. Phys., 51: 3627-8(Oct. 15, 1969).

A small-angle scattering approximation was used to calculate glory undulations in the scattering of atoms by homonuclear diatomic molecules. Calculations were made for vibrating and nonvibrating molecules and for two orientations: (1) molecular axis parallel to the trajectory of the incident atom and (2) axis perpendicular to the trajectory. The results indicate that the change in polarizability and the geometrical distinctions caused by molecular vibrations have small effect upon glory scattering in this case. Since the amplitude of vibration and the change of polarizability used are representative of most molecules, it is probable that this result is general. The strong dependence of glory undulations upon orientation is in agreement with previous calculations that indicate that anisotropy in the intermolecular potential causes quenching. (A.G.W.)

1292 QUANTUM MECHANICS OF THE H + H_2 REACTION: INVESTIGATION OF VIBRATIONAL ADIABATIC MODELS. Wyatt, Robert E. (Univ. of Texas, Austin). J. Chem. Phys., 51: 3489-3502(Oct. 15, 1969).

The effects of reaction-path curvature and angular-momentum state on reactive H + H_2 collisions are investigated for the rotating linear model: three atoms constrained to a line free to rotate in three-dimensional space. Three vibrational adiabatic approximations to the quantum-mechanical scattering problem are investigated after introducing Marcus' natural-collision coordinates. Calculations based upon the Porter and Karplus H_3 surface are presented for the following reaction properties: local vibrational and translational energy, reaction probabilities, and reaction cross sections. Tunneling, the internal centrifugal effect, and the energy dependence of reaction coordinates are also considered. (auth)

1293 QUENCHING OF GLORY UNDULATIONS: BREATHING SPHERE MODEL. Helbing, R. K. B. (General Dynamics/Convair, San Diego, Calif.). J. Chem. Phys., 51: 3628-9(Oct. 15, 1969).

A "breathing sphere" potential model was used to calculate glory undulations in the scattering of atoms by molecules. The high-energy approximation was used for the frequency-dependent part of the phase shift. Results are shown for scattering of Li by CCl_4. Comparison with experimental results showed that it was impossible to even approach the experimental data by using parameters that could be reasonably accounted for by a vibration of the repulsive core of the potential or by a change in polarizability due to vibration. Since this result was typical of all cases studied, it is concluded that vibration is only a minor cause for glory quenching if it is a cause at all. (A.G.W.)

1294 TEMPERATURE DEPENDENCE OF DISSOCIATIVE ATTACHMENT IN N_2O. Chantry, P. J. (Westinghouse Research Labs., Pittsburgh). J. Chem. Phys., 51: 3369-79(Oct. 15, 1969).

The attachment of low-energy electrons (<4 eV) by the reaction

$e + N_2O \rightarrow O^- + N_2$ was studied as a function of gas temperature from approximately 160 to 1040°K. The ions produced by a monoenergetic electron beam are detected by total ion collection or by mass analysis. The kinetic energy distributions of the O^- ions have also been measured and found to be relatively insensitive to the electron energy when the latter exceeds 1.5 eV, in which case the most probable ion energy is 0.38 eV. The shape and magnitude of the cross section below 2 eV is found to be sensitive to gas temperature throughout the range studied. The differences in shape and threshold observed by previous workers occur below 2 eV and to a large extent may be reconciled in terms of the differing gas temperatures employed. The temperature insensitive portion of the cross section is ascribed to electron capture into the highest energy N_2O^- state connected to electronic ground state $N_2 + O^-$. The O^- kinetic energy distributions arising therefrom are explained in terms of the N_2O^{-*} potential-energy surface involved. It is argued that the strongly temperature-sensitive portion of the cross section is due predominantly to excitation of the bending mode of vibration, and arises from the dependence on bond angle of the separation in energy of the electronic ground states of N_2O and N_2O^-. (auth)

1295 APPLICATION OF APPROXIMATION METHODS FOR THE CALCULATION OF THE TOTAL DIFFERENTIAL IONIZATION CROSS SECTIONS TO H. Tavard, C. (Univ. of Indiana, Bloomington). J. Chem. Phys., 51: 3342-3(Oct. 15, 1969).

An attempt to improve the description of the differential ionization cross sections is discussed in the special case of electron impact ionization for the hydrogen atom. (auth)

1296 FORMATION OF N_2O^- VIA ION–MOLECULE REACTIONS IN N_2O. Chantry, P. J. (Westinghouse Research Labs., Pittsburgh). J. Chem. Phys., 51: 3380-4(Oct. 15, 1969).

The production of O^-, NO^-, and N_2O^- by electron impact on N_2O has been studied as a function of pressure in the range 10^{-6} to 5×10^{-3} torr, using a quadrupole mass filter. The respective linear, quadratic, and cubic pressure dependences observed for these ions and their relative signals are consistent with the following reaction sequence and cross sections: $e + N_2O \rightarrow O^- + N_2$, $O^- + N_2O \rightarrow NO^- + NO$ (3×10^{-16} cm^2), and $NO^- + N_2O \rightarrow N_2O^- + NO$ (1×10^{-16} cm^2). An alternative explanation of the data in terms of the three-body reaction converting O^- to N_2O^- is rejected because of the implausibly large coefficient required to explain the data. No other reactions were detected. Discrepancies between the present results and those of other workers are discussed quantitatively. It is suggested that N_2O^- formation by the presently proposed reaction may well be endothermic, accounting for its nonappearance in systems used to study thermal energy reactions. (auth)

1297 QUANTUM VIBRATIONAL TRANSITION PROBABILITIES IN ATOM–DIATOMIC MOLECULE COLLISIONS. Cheung, Agnes S.; Wilson, David J. (Univ. of Rochester, N. Y.). J. Chem. Phys., 51: 3448-57(Oct. 15, 1969).

A generalization of the method of Shuler and Zwanzig is shown to permit the calculation of the scattering matrix for collinear atom–diatomic molecule systems having rather general intermolecular potentials. The procedure is related to the method of invariant imbedding. It is then applied to the calculation of transition probabilities for a harmonic oscillator molecule interacting with the bombarding atom via a hard-sphere potential with a "step", i.e., $V(y) = \infty$, $y < \sigma_0$; $V(y) = V_1$, $\sigma_0 \leq y < \sigma_1$; $V(y) = 0$, $\sigma_1 \leq y$, where y is the distance between the bombarding atom and the nearest end of the molecule. The dependence of the transition probabilities on the height (depth) and width of the potential step is studied. Resonance effects on the transition probabilities were observed; these involve the De Broglie wavelength of the collisional motion and the width of the potential step. Application of this approach to diatomic–diatomic collisions is outlined. (auth)

Atomic Theory

1298 VARIATIONAL PRINCIPLE FOR THE CORRECTION OF THE THIRD-ORDER ENERGY IN PERTURBATION THEORY. Dmitriev, Yu. Yu.; Yur'ev, M. S. (Leningrad State Univ.). Chem. Phys. Lett., 4: 43-4(Sept. 15, 1969).

A variational method for the calculation of the third-order correction without using the correction function of the first order is suggested. ϵ_3 in 1/Z expansions for two-electron atoms is calculated. The method of evaluating the lower bound for ϵ_3 is described. (auth)

1299 VARIATIONAL UPPER AND LOWER BOUNDS FOR THE CORRECTION OF THE SECOND-ORDER ENERGY IN 1/Z EXPANSIONS FOR TWO-ELECTRON ATOMS. Dmitriev, Yu. Yu.; Yur'ev, M. S. (Leningrad State Univ.). Chem. Phys. Lett., 4: 45-7(Sept. 15, 1969).

A method of evaluation of the upper and lower bounds of the second-order perturbation of the energy is described. The calculation of upper and lower bounds for the second-order perturbation of the energy in 1/Z expansions for two-electron atoms is given. (auth)

1300 ON THE UNRESTRICTED HARTREE–FOCK WAVE FUNCTION. Nakatsuji, Hiroshi; Kato, Hiroshi; Yonezawa, Teijiro (Kyoto Univ.). J. Chem. Phys., 51: 3175-80(Oct. 15, 1969).

The unrestricted Hartree–Fock (UHF) wave function is analyzed and interpreted in configuration-interaction (CI) language. The results of the present study are as follows: (1) The UHF wave function includes only one type of the singly excited configurations, and thus the correlation effects included are very limited ones compared with the usual CI treatment. (2) The weight of the lowest contaminating spin function, included in the UHF wave function, decreases with increasing spin multiplicity. (3) The annihilation of the lowest contaminating spin function little affects the electron density distributions and other physical quantities, the operators of which commute with the annihilation operator. (4) In the UHF method, the "spin-appearing" (spin-polarization and spin-delocalization) mechanisms are clearly divided, and an approximate method to separate these contributions is generalized, and some discussions about spin annihilation are made. (auth)

Cosmic Radiation

Refer also to abstracts 1152, 1169, 1177, 1178, 1201, 1223, 1239, 1250, 1335, and 1498.

1301 POSSIBILITY OF COSMIC RAYS BEING TRANSIENT. Wayland, J. R. (Univ. of Maryland, College Park). Planet. Space Sci., 17: 1619-28(Sept. 1969).

The possible observable effects that may be produced if the flux of cosmic radiation is time-dependent are considered, and the time-dependent problem to find possible time variation in both the intensity and the momentum spectrum was solved. It is concluded that cosmic radiation may be locally transient with a quasi-steady state on the large scale of the Galaxy (or perhaps metagalaxy). (auth)(UK)

1302 CORRELATION OF MEASUREMENTS TAKEN IN THE PROTON SATELLITE AND DATA ON SIDEREAL–DIURNAL VARIATIONS OBTAINED WITH VARIOUS MODELS OF COSMIC-RAY ORIGINS. Dorman, L. I. Kosm. Issled., 7: 402-14(May-June 1969). (In Russian).

Various models of metagalactic and galactic cosmic-ray origins were studied from the point of view of correlating them to various conditions (spallation of proton and nuclear spectra in the region of hard particles according to the observations obtained with the proton satellite; up-to-date data on the stellar–diurnal variations of cosmic rays; and distortions of the energy spectra and nuclear composition in interplanetary space). Data obtained indicate the advantages of galactic simulation, mainly heavy nuclei generation in the initial period of formation of supernova and fragmentation during diffusion in the shell. The stationary model of cosmic rays produced during periodic flashes of quasi-stellar objects in the center of the galaxy could also be used, considering mainly the conditions that generated mostly heavy nuclei and fragmentation. (R.V.J.)

1303 ANGULAR ANISOTROPY OF CORPUSCULAR RADIATION IN A STATIONARY GEOMAGNETIC FIELD. II. Troshichev, O. A. Kosm. Issled., 7: 454-6(May-June 1969). (In Russian).

The angular anisotropy function of corpuscular radiation in a stationary geomagnetic field was studied at maximum density of particle capture fixed at two points of the equatorial region in which the function possessed two maximums at pitch angles close to 0 and $\pi/2$. Results showed that at $\alpha = -1.0$, irrespective of the ratio of the density $n_{\alpha 0}/n_{b0}$ in the equatorial plane, the total particle density increased rapidly with the latitude and reached the maximum near the mirror points. With $\alpha = 1.2$ the distribution of the particle density $n(\varphi)$ depends mainly on the magnitude of the coefficient L. At L = 10, the relative density $n(\varphi)/n_0$ had two clearly expressed maximums at the equatorial plane and near the mirror points. Thus, the maximum density of captured particles was fixed near the surface layer (high latitudes) and at remote points from the Earth (low latitudes). (R.V.J.)

1304 THE SURVIVAL OF HEAVY NUCLEI IN COLGATE'S SUPERNOVA-ACCELERATION MODEL FOR COSMIC RAYS. Kinsey, James H. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J., 158: 295-302(Oct. 1969).

Colgate's supernova-acceleration model for cosmic rays is examined to see if heavy nuclei can indeed survive such catastrophic acceleration. If it is assumed that all species of nuclei are collectively accelerated by a mechanism such as a plasma-wave instability in a shock wave, then the only factor remaining to dissociate heavy nuclei in Colgate's model is the blueshifted photon flux in the shock wave which moves radially outward. This would produce a sharp cutoff in the heavy component of cosmic rays by photodisintegration of the heavy nuclei for final cosmic-ray energies greater than 10^3 GeV per nucleon. (auth)

1305 ANGULAR DISTRIBUTION OF MUON-POOR EXTENSIVE AIR SHOWERS. Catz, Ph. (Cosmic Ray Physics Lab., Verrieres le Buisson, France); Maze, R.; Gawin, J.; Przasnycki, M.; Wdowczyk, J.; Zawadzki, A. Phys. Rev. Lett., 23: 988-90 (Oct. 27, 1969).

Angular distribution of muon-poor extensive air showers was found to be flatter than that of normal showers. The result excludes any possibility that muon-poor showers are initiated by primary photons. It is likely that the showers are generated by some relatively passive particles which are produced through interactions between the primary cosmic rays and the atmospheric nuclei. (auth)

1306 DIFFUSE RADIATION IN THE HIGH-ENERGY REGION. Morrison, P. (Massachusetts Inst. of Tech., Cambridge). pp 393-9 of Contemporary Physics: Trieste Symposium 1968. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.1); CONF-680629(Vol.1).

Topics discussed include the power-law x-ray background, the thermal x-ray background (if any), gamma rays, high-energy radiations, low-energy pools, and other radiations. (auth)

1307 SCATTERING OF BACKGROUND X RAYS BY METAGALACTIC ELECTRONS. Rees, M. J. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Astrophys. Lett., 4: 113-15(Oct. 1969).

If the celestial x-ray and γ-ray background originates at large cosmological redshifts, the photons may have undergone scattering by metagalactic electrons. There would then be a characteristic distortion of the emitted spectrum, especially in the hard x-ray region. (auth)

1308 INTENSITY MEASUREMENT OF α COMPONENT IN PRIMARY COSMIC RAYS AT A LOCATION OF GEOMAGNETIC CUTOFF RIGIDITY 11.0 GV. Kondo, Ichiro (Nagoya Univ., Japan); Sakai, Takasuki. Tokyo Daigaku Uchu Koku Kenkyusho Hokoku, 5: 170-81(Mar. 1969). (In Japanese).

Based on the preliminary experiment in 1966, the measurement of vertical intensity on the α component in primary cosmic radiation was made on Sept. 8, 1967, at an altitude of 17.4 ± 1.2 g·cm^{-2} at a location of geomagnetic cutoff rigidity 11.5 GV, using a Cherenkov scintillation counter tellescope carried by a balloon. The measured value of the integral intensity of the α component in the primary cosmic radiation during the quiet Sun period, was $23.0 \pm 1.6/m^2 \cdot$ ster. sec (the error being standard deviation). (auth) (NSA of Japan)

Direct Energy Conversion

Refer also to abstract 257.

1309 (ANL-7575, pp 136-69) ENERGY CONVERSION. Cairns, E. J.; Tevebaugh, A. D.; Bingle, J. D. (Argonne National Lab., Ill.).

ALUMINUM CHLORIDES—Raman frequencies of gaseous Al_2Cl_6, analysis
BISMUTH—solubility in sodium at 125 to 250°C
BISMUTH ALLOYS AND SYSTEMS—Bi-Na, thermodynamic data on, quasi-ideal solution theory treatment of
—Bi-Na, phase diagram
CALCIUM ZIRCONATES—compatibility testing as insulator in lithium cells
ELECTROLYTES—properties of paste, disks with lithium-halide eutectic
ELECTROLYTIC CELLS—regenerator design studies for lithium-tin system, thermal
—performance of lithium secondary, with selenium, sulfur, and phosphorus cathodes
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IRON—corrosion of Armco, by liquid tellurium
—corrosion by selenium at 375°C, static
LITHIUM—compatibility testing with ceramic insulator materials at 400 to 550°C under cell conditions
LITHIUM ALLOYS AND SYSTEMS—Li-Sn, phase equilibrium studies
—Li-Te, thermodynamics of, emf studies
—Li-Te, phase studies
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LITHIUM CHLORIDES—KI-LiCl-LiI, phase studies
LITHIUM IODIDES—KI-LiCl-LiI, phase studies
—HgI_2-KI-LiI, spectrum of molten, Raman
LITHIUM SELENIDES—spectrum of solid Li_2Se, pressure effects on infrared
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MAGNESIUM BROMIDES—KBr-$MgBr_2$, spectrum of molten, Raman
MAGNESIUM CHLORIDES—KCl-$MgCl_2$, spectrum at 550°C, resolution of Raman
MERCURY IODIDES—spectrum of molten HgI_2, Raman
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MOLYBDENUM—corrosion by selenium at 375°C, static
MOLYBDENUM ALLOYS AND SYSTEMS—Mo-base-W, corrosion by tin at 1300°C
—Mo-base-Ti-Zr, corrosion by tin at 1300°C
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NIOBIUM ALLOYS AND SYSTEMS—Nb-base-Ta-W-Zr, corrosion of Fansteel 85 by selenium at 375°C, static
—Nb-base-W-Zr, corrosion by tin at 1300°C
—Nb-base-Ta-W-Zr, corrosion by tin at 1300°C
PHOSPHORUS—performance as cathode in lithium secondary cells
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POTASSIUM CHLORIDES—KCl-$MgCl_2$, spectrum at 550°C, resolution of Raman
—KCl-NaCl-UO_2Cl_2, spectrum at 600°C, Raman
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—HgI_2-KI-LiI, spectrum of molten, Raman
RHENIUM ALLOYS AND SYSTEMS—Re-W, corrosion by tin at 1300°C
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—corrosive effects on metals at 375°C, static
SODIUM—solvent properties for bismuth at 125 to 250°C
SODIUM ALLOYS AND SYSTEMS—Bi-Na, thermodynamic data on, quasi-ideal solution theory treatment of
—Bi-Na, phase diagram
SODIUM CHLORIDES—KCl-NaCl-UO_2Cl_2, spectrum at 600°C Raman
SULFUR—performance as cathode in lithium secondary cells
TANTALUM—corrosion by selenium at 375°C, static
TANTALUM ALLOYS AND SYSTEMS—Ta-base-W, corrosion by selenium at 375°C, static
—Nb-base-Ta-W-Zr, corrosion of Fansteel 85 by selenium at 375°C, static
—Nb-base-Ta-W-Zr, corrosion by tin at 1300°C
TELLURIUM—performance as cathode in lithium secondary cells
—corrosive effects on iron at 455 and 480°C
TELLURIUM SYSTEMS—Li-Te, thermodynamics of, emf studies
—Li-Te, phase studies
TIN—corrosive effects on refractory metals at 1300°C
TIN ALLOYS AND SYSTEMS—Li-Sn, phase equilibrium studies
TITANIUM ALLOYS AND SYSTEMS—Mo-base-Ti-Zr, corrosion by tin at 1300°C
TUNGSTEN—corrosion by tin at 1300°C
TUNGSTEN ALLOYS AND SYSTEMS—Ta-base-W, corrosion by selenium at 375°C, static
—Nb-base-Ta-W-Zr, corrosion of Fansteel 85 by selenium at 375°C, static
—Mo-base-W, corrosion by tin at 1300°C
—Re-W, corrosion by tin at 1300°C
—Nb-base-W-Zr, corrosion by tin at 1300°C
—Nb-base-Ta-W-Zr, corrosion by tin at 1300°C
URANYL CHLORIDES—KCl-NaCl-UO_2Cl_2, spectrum at 600°C, Raman
ZIRCONIUM ALLOYS AND SYSTEMS—Nb-base-Ta-W-Zr, corrosion of Fansteel 85 by selenium at 375°C, static
—Nb-base-W-Zr, corrosion by tin at 1300°C
—Nb-base-Ta-W-Zr, corrosion by tin at 1300°C
—Mo-base-Ti-Zr, corrosion by tin at 1300°C (D.L.C.)

1310 ON THE FUNDAMENTAL PHENOMENON OF MAGNETOHYDRODYNAMIC ENERGY CONVERSION. Csoersz, E.

(Matra Regional Metal Works, Sirok, Hungary). Acta Tech. Acad. Sci. Hung., 65: 43-55(1969).

A mathematical analysis was made of a direct-current MHD generator operating with a quasi-neutral gas plasma as a working fluid. The energy conversion mechanism considered to be the fundamental phenomenon in a MHD generator is interpreted as follows. In the magnetic field through which the working fluid is flowing, a braking force may act upon the electrically charged particles of the fluid. However, this effect can only be important on electrons and even in this case only when they are delivering electrical energy to the external load of the generator, at the expense of the kinetic energy due to their ordered motion. Thus, an electrostatic force may appear between the braked electrons and the positive ions that continue their flow. Consequently, the kinetic energy of the ions decreases and the energy difference can be converted into electric energy and extracted from the generator. The electrically neutral particles, however, which are carrying a more important component of the kinetic energy in the plasma will compensate for these energy losses by momentum transfer when colliding with the ions. Through these effects the kinetic energy of the neutral component may contribute to the electric energy of the generator in accordance with the efficiency of the process. The analysis presented is based on the relations of plasma equilibrium. The strength of the gas-dynamic forces acting on various plasma components is considered as a product of partial pressure gradients and momentum transfer probabilities. Some basic relations for the design of power generators are derived. (BBB)

1311 TRANSIENTS IN THE CHANNEL OF A CONDUCTION MHD GENERATOR WITH A NONLINEAR INDUCTANCE IN THE EXTERNAL CIRCUIT. Khozhainov, A. I. Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 129-33(July 1969).

Translated from Zh. Tekh. Fiz., 39: 184-9(Jan. 1969).

An analytical solution is given of the transient response in the plane channel of a liquid-metal conduction MHD generator with a nonlinear complex load in the noninductive approximation. The following cases are studied: 1) switching of the load while maintaining a constant consumption of liquid metal, and 2) startup with the load connected. In the second case a solution is formulated using segments of the piecewise-linear approximation of the magnetization curve. It is shown that the presence of a nonlinear inductance in the electrical circuit of the MHD generator leads to the formation of short current peaks in startup. (auth)

Fluid Physics

1312 MAGNETOHYDRODYNAMIC FLOW THROUGH A RECTANGULAR DUCT DUE TO A PERIODIC PRESSURE GRADIENT. II. Mandal, K. K. (Indian Inst. of Tech., Kharagpur). Appl. Sci. Res. (The Hague), 21: 1-12(Aug. 1969).

An analysis is made of the flow of an incompressible, viscous, electrically conducting fluid in a long channel of rectangular cross section due to a periodic pressure gradient, in the presence of a uniform transverse magnetic field. Exact solutions are obtained and asymptotic forms valid for large Hartmann numbers in the boundary layers parallel to the field are discussed. (auth)

1313 DISSIPATIVE CONSERVATION LAWS IN MAGNETOHYDRODYNAMICS. Laprus, W. (Inst. of Fundamental Technical Problems, Warsaw). Arch. Elektrotech. (Warsaw), 17: 285-92(1968). (In Polish).

A number of possibilities of casting the magnetohydrodynamic equations into a form of divergence is considered. It is given an effective substitution for the state variables, which leads to the form of the dissipative conservation laws studied by Kulikowski (one-dimensional motion). It is also proved that such a substitution does not exist for the three-dimensional case. (auth) (NSA of Poland)

1314 TURBULENT MAGNETOFLUIDMECHANIC FLOW IN A PIPE WITH AXIAL FIELD. Lykoudis, Paul S. (Purdue Univ., Lafayette, Ind.). pp 373-9 of Turbulence of Fluids and Plasmas. Fox, Jerome (ed.). Brooklyn, Polytechnic Press of the Polytechnic Inst. of Brooklyn, 1969.

From Symposium on Turbulence of Fluids and Plasmas, New York. See CONF-680431.

Fully established turbulent flows are described for an electrically conducting fluid in the presence of an aligned-to-the-flow magnetic field. The channel is assumed to be electrically insulated. The semi-empirical theory of Lykoudis and Brouillette is extended to this case. Comparison of skin friction experimental data with theoretical results yields good agreement. (auth)

1315 DISPERSION OF MATTER IN MAGNETOHYDRODYNAMIC FLOW BETWEEN TWO PARALLEL PLATES. Erdogan, Emin (Technical Univ., Istanbul). J. Mec., 8: 229-37(June 1969).

The theory of G. I. Taylor (Proc. Roy. Soc., A-219: 186-203 (1953)) regarding dispersion of a solute in a solvent flowing through a tube was applied to magnetohydrodynamic flow systems. The analysis reported here considered the dispersion of matter through electrically conducting fluid flowing between two insulated parallel plates in the presence of a transverse magnetic field. The velocity profile nondimensionalized by the mean velocity of the flow depends on the Hartmann number, which is a measure of the ratio of the electromagnetic forces to the viscous forces. As the Hartmann number increases, the velocity profile becomes flatter over the cross section of the channel. This uniformity of the velocity affects the concentration distribution over the cross section. The distribution of the concentration over the cross section becomes more uniform. Therefore, the concentration flux across a plane which moves at the mean speed of the flow decreases. Thus, as Hartmann number increases the concentration flux decreases. An equation giving the distribution of the mean concentration was derived that allows comparison of theoretical and experimental results. (BBB)

Geophysics (Upper Atmosphere)

1316 BURSTS OF VLF EMISSION SIMULTANEOUS WITH SHARP DIP OF ABSORPTION AND SC IN GEOMAGNETIC H. Harang, L. (Norwegian Defence Research Establishment, Kjeller). Planet. Space Sci., 17: 1565-72(Sept. 1969).

Observations of vlf emissions on 8 kc/s close to the auroral zone at Tromsø during sharp and sudden dips of ionospheric absorption (recorded via a riometer on 28 Mc) and SC-like deflections in H were analyzed. It is pointed out that the sharp dip of absorption is very often preceded by series of vlf emissions, which disappear when the absorption dip develops, and it is pointed out also that the vlf emissions start to decrease 1 to 2 min before the strong dip of absorption develops. It is shown, however, that the start of the vlf emission seems to coincide with the SC deflection in H and that the disappearance of vlf burst during the absorption dip must be due to the increased ionospheric absorption of the vlf waves. The displacement in time of the absorption dip relative to the vlf emission spike may be interpreted as a delay time for the formation of the ionospheric absorption layer, and quantitative estimates support this point of view. It is noted that the corpuscular ionization process in the D layer is switched off before the steady-state condition is attained, and that the intensity of the corpuscular bundle must be orders of magnitude higher than during smooth and gradual absorption events. The diurnal variations of the sudden absorption events, SCA, at Tromsø and Churchill are compared; at Churchill there is a maximum around 22 hr geomagnetic time, at Tromsø around 24 hr. (auth)(UK)

1317 EQUATORIAL MEASUREMENTS OF THE [O I] 5577-A EMISSION OF THE DAYGLOW WITH A ROCKET PHOTOMETER. Dandekar, B. S. (Northeastern Univ., Boston. Air Force Cambridge Research Labs., Bedford, Mass.). Planet. Space Sci., 17: 1609-18(Sept. 1969).

Observations of the [O I] 5577 Å emission of the dayglow were made with a rocket photometer from the equatorial launch site at Natal, Brazil. The observations show that contributions to the [O I] 5577 Å emission of the dayglow come from three different ranges of altitudes. The lower layer is around 96 km, with half emission width of about 23 km and peak emission of about 330 photons/cc. This layer contributes about 40% of the total emission, and is similar to the layer which contributes most of the [O I] 5577 Å emission of the nightglow. The excitation is of chemical origin. The second layer is in the altitude range of 110 to 150 km. The probable excitation mechanism is the photodissociation of O_2. The third layer is above 150 km. The excitation mechanism in this case is the process of recombination of O_2^+ and ionospheric electrons, and also the excitation of O_2 by photoelectrons. This contributes about 30% to the dayglow emission. (auth)(UK)

1318 ELECTRON CONTENT MEASUREMENTS BY BEACON S-66 SATELLITE DURING THE MAY 20, 1966, SOLAR ECLIPSE. Anastassiadis, Michael; Matsoukas, Demetrius (Univ. of Athens). J. Atmos. Terrest. Phys., 31: 1217-22 (Sept. 1969).

The effect of an eclipse on the total electron content of the ionosphere was investigated, using the satellite technique. Tracking centers were installed at Florence, Athens, Alexandroupolis, and on Crete. It was found that all values of electron content measured between 42 and 35°N latitude during the first half of the annular

solar eclipse of May 20, 1966, were increased in comparison with values observed from the same latitudes during control days. The increased values reached a maximum at 38°N. These results indicate a competing action between the mechanism causing electron content increases and the mechanism causing reduction of electron content. (UK)

1319 PROLONGED IONOSPHERE PERTURBATIONS INDUCED BY HIGH-ALTITUDE THERMONUCLEAR EXPLOSIONS. Cherkas, V. I. Kosm. Issled., 7: 429-35(May-June 1969). (In Russian).

Statistical data obtained on radio signals recorded by the satellite instruments were used for determining the basic regularities in the distribution of small-scale heterogeneities of electron density in the quiet ionosphere and under the conditions of the thermonuclear explosion Starfish. A long-duration intense minimum of ionosphere perturbation that formed following the nuclear explosion was recorded in the medium-latitude stratosphere. Data obtained confirmed the postulation that the ionosphere inhomogeneities on a planetary scale were related to the processes taking place in the radiation belts of the Earth. (tr-auth)

1320 MORPHOLOGY OF THE PULSATING AURORA. Kvifte, G. J.; Pettersen, H. (Auroral Observatory, Tromsoe, Norway). Planet. Space Sci., 17: 1599-1607(Sept. 1969).

Observations of pulsating aurora were made from Tromsø during the Winter 1967–68. The data which were obtained from 4 photometers pointing in different directions in the meridian plane were analyzed to investigate the diurnal variation of the occurrence of pulsating aurora. The dependence on latitude and magnetic activity was also investigated. The results indicate that the pulsating aurora mainly occurs in a spiral-shaped region situated in the southern part of the morning sector of the auroral oval. (auth) (UK)

1321 HYDROXYL EMISSION OF THE UPPER ATMOSPHERE. II. EFFECTS OF A SUNLIT ATMOSPHERE. Shefov, N. N. (Inst. of Physics of the Atmosphere, Moscow). Planet. Space Sci., 17: 1629-39(Sept. 1969).

On the basis of observations made at Zvenigorod the measured average seasonal variations of the population of the fifth vibrational level and the vibrational temperature of OH molecules, seasonal variations of the populations of the levels with $V' = 1$ to $V' = 9$, and the total energy of the hydroxyl emission, were obtained. In summer, at a time when heights above 70 km are fully sunlit during the whole day, the total energy of the OH emission and the intensity of the bands from the lower vibrational levels are maximum, while in winter they are minimum. The intensities of the bands from the upper vibrational levels are minimum in summer and maximum in winter. From these data the hydroxyl emission diurnal variations were obtained and are compared with the data of direct measurements. (auth) (UK)

1322 IONOSPHERIC COMPOSITION MEASUREMENTS WITH AN RF IMPEDANCE PROBE. Miller, E. K.; Schulte, H. F. (Univ. of Michigan, Ann Arbor). Planet. Space Sci., 17: 1641-56(Sept. 1969).

Consideration is given to extending various methods used for determining electron number density in the ionosphere to ion composition measurements. A technique involving the impedance of an antenna operated in a frequency range or the order of the ion cyclotron frequency to the electron cyclotron frequency appears promising. Theoretical impedance results for some idealized combinations of ions, as well as typical ion mixtures encountered in the ionosphere, illustrate application of the technique. The advantages and limitations of the impedance probe are discussed. (auth) (UK)

1323 THE AURORAL ORIENTATION CURVES FOR THE IQSY. Gustafsson, G. (Kiruna Geophysical Observatory, Sweden); Feldshtein, Ya. I.; Shevnina, N. F. Planet. Space Sci., 17: 1657-66(Sept. 1969).

The auroral orientation curves for IQSY were evaluated from the all-sky camera data obtained at 13 stations. Comparing the orientation curves from IGY and IQSY it was found that the dawn–dusk asymmetry which was pronounced in the IGY curves disappeared in those of IQSY. On the other hand, the day-night asymmetry remained unchanged between the two periods of time. The auroral oval defined from the occurrence of the aurora is closely related to the auroral orientation curves, and it was found that the auroral orientation curve crossing the midnight meridian at 68° corrected geomagnetic latitude lies within the auroral oval for a corresponding period and this is 1° closer to the pole than during IGY. The majority of the auroral arcs are due to precipitated electrons in an energy range of about 1 to 20 keV. The precipitation pattern in this energy range as measured by satellites was compared with the location of the auroral orientation curves and a reasonably good agreement was found. (auth) (UK)

1324 ELECTRON CONTENT OF THE LOW-LATITUDE IONOSPHERE. Titheridge, J. E.; Smith, W. D. (Univ. of Auckland, New Zealand). Planet. Space Sci., 17: 1667-76 (Sept. 1969).

The electron content of the ionosphere was determined at latitudes of 5°S to 35°S during 354 transits of the satellite S-66 recorded at Rarotonga. In winter the peak of the equatorial anomaly forms between 0700 and 0900 LT. It remains at a latitude of 8°S throughout the day, and decays slowly overnight. In summer the peak forms between 0830 and 1030 LT, at a latitude of 10°S. It moves to 17°S by 1400 LT, returning to 10°S as it disappears near sunset. The size of the peak is about the same in both seasons, although the electron content has a seasonal variation of 3:1 at higher latitudes. There is a sharp transition from the approximately constant electron content at medium latitudes to the rapidly increasing content near the equatorial zone. This transition point is at about 21°S in winter, and 23°S in summer. (auth) (UK)

1325 PREDAWN ENHANCEMENT OF 6300-A AIRGLOW IN CONJUGATE REGIONS. Carman, E. H.; Hatzopoulos, G. J.; Heeran, M. P. (Univ. of Botswana, Lesotho, S. Afr.). Planet. Space Sci., 17: 1677-9(Sept. 1969).

Observations of 6300-Å airglow during the predawn period in two approximately conjugate regions: Sounion (lat 37.7°N, long. 24.0°E) in Greece, and Roma (lat 29.7°S, long. 27.7°E) in Lesotho, Southern Africa, are reported. The time of first appearance of the enhancement was deduced from isophote sky maps and an estimate of the height of emission of conjugate photoelectrons causing the phenomenon was made. Results from both places indicated that photoelectrons emitted from about 400 km caused the early stages of predawn enhancement. (UK)

1326 ELECTRON CONTENT MEASUREMENTS AT HYDERABAD USING BEACON SATELLITE TRANSMISSIONS. Rama Rao, C.; Rao, E. Bhagiratha; Subbaraju, G. C. (Defence Electronics Research Lab., Hyderabad, India). J. Atmos. Terrest. Phys., 31: 1197-1203(Sept. 1969).

Measurements of electron content carried out at Hyderabad, a low-latitude station, are presented for the period October 1964–February 1967. The diurnal and seasonal variations are discussed and results compared with those from other stations. (auth) (UK)

1327 ELECTRIC FIELD EFFECTS IN THE MIDDLE-LATITUDE F REGION. Bramley, E. N. (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys., 31: 1223-7(Sept. 1969).

Time-varying solutions of the F-region continuity equation are given, which show the effect of including an east–west electric field, such as may arise from ionospheric dynamo action, in addition to neutral air winds and other usual processes. Using ionospheric parameters representative of equinox conditions at middle latitudes, a reasonable magnitude of electric field is shown to give fairly small but not negligible effects in both the peak electron density N_m and the height of the peak h_m. It is concluded that electric fields should not be neglected when attempting precise comparisons with experimental data. (auth) (UK)

1328 THE ACQUISITION AND USE OF IONOSPHERIC DATA FOR PREDICTION AND OTHER PRACTICAL APPLICATIONS. Piggott, W. R. (Radio and Space Research Station, Slough, Eng.). Telecommun. J., 36: 273-9(June 1969).

Cooperation between communications engineers and ionospheric physicists, sites for new fixed ionosondes, acquisition of additional data by automatic equipment and satellites, reliability of data, treatment of spread-F, use of existing topside data, and use of modified topside sounders in satellites are discussed. Cheap, reliable semi-automatic equipment for limited information, or satellites, could be used to measure the following, at every 100 Km along the path: critical frequency or top frequency of spread echoes; plasma frequency at the satellite; a single height parameter; and possibly sporadic E in certain areas. Monthly medians of ionospheric data based on less than half the maximum possible count are liable to be in error. A comparison between sample IGY and IQSY data shows a significant decrease in the completeness of the data per station for the latter period. The ratio of fxS (top frequency of spread) to foF2 is often very large (3 or more) and even when it is small, fxS is appreciably greater than foF2. The International Scientific Radio Union has, therefore, adopted fxS as a new parameter for international exchange. Topside sounder data could be used to establish mean gradients of critical frequency at constant local time, to delineate the mean shape of the variations with position, and to establish coordinate systems for simplification of data interpolation and extrapolation rules. The operational objectives of an ionosonde satellite would be as follows: study of fxF2 and hmF2 in unmonitored areas; determination of the extrapolation and interpolation rules critical

frequency and height of the F2 layer; finding where key monitoring stations should be maintained; data for new methods of prediction; and finding excess E_s. Variations in the critical frequency of the F2 layer, the top frequency of spread-F when this exceeds fxF2, the height of the maximum of the F2 layer, the electron density at the satellite, and the top frequency of E_s when this exceeds foF2 can similarly be studied. (BBB)

1329 THE PERSISTENCE OF SOLAR AND GEOMAGNETIC ACTIVITY. PART I. Cehak, K.; Pichler, H. (Univ., Vienna). Arch. Meteorol., Geophys. Bioklimatol., Ser. A, 18: 147-56(1969). (In German).

By use of the method of variance spectrum analysis, an investigation was made of the persistency of some parameters of solar and geomagnetic activity. The monthly means of sunspot numbers and the 10.7-cm radiation flux showed nearly identical autocorrelation functions with long persistency. The spectra contain only very long waves. The spectrum of the solar flare index contains a wave with a period of about 10 months, but is otherwise very similar to the other solar spectra. The spectra of the series of the sum of K_p indices and of the series of A_p indices show waves with periods of about 2, 6, and 48 months. This indicates that solar wind data are more useful for correlations with geomagnetic indices than the solar indices mentioned above. (BBB)

1330 THE RESULTS OF POLAR LIGHT OBSERVATIONS IN THE IGY AND IQSY WITH SPECIAL CONSIDERATION OF THE CONTRIBUTIONS OF GERMAN SHIPS. Lange-Hesse, G. Seewart, 30: 89-106(June 1969). (In German).

Reports of the morphology (including auroral substorms) and mechanisms of excitation of auroral displays during the IGY and IQSY are given. Electron polar lights are produced by electrons of energies of 10 keV maximum, as determined especially during the IQSY. Ionization and excitation is chiefly a result of secondary electron collisions. Frequently observed lines assigned to this mode of excitation are the first negative N_2^+ band at 3914 Å, and the green and red 0 line. Auroras produced by protons show strong Balmer Hα and Hβ lines and show a different type of morphology, a weak glow of the form of a wide band 100 Km wide and more than 1000 Km long, lying in the early night hours south of the brighter electron auroras, moving into the electron band at midnight, and lying north of the electron band in morning hours. A description of reporting networks and programs during the IGY and the IQSY is given. (BBB)

1331 IONOSPHERIC REFLECTION COEFFICIENT OF THE ELF RADIO WAVES. Sao, Kazuo (Nagoya Univ., Japan). Electron. Commun. Jap. (Engl. Transl.), 50: 54-63(June 1967).

The vlf band (from 30 to 3 KHz) the ionospheric reflection coefficient is usually obtained assuming specular reflection. However, this is appropriate only under conditions of homogeneous anisotropy or inhomogeneous isotropy, and it is believed that for long wavelengths as in the elf band (from 3 KHz to 1 Hz) it is insufficient to regard reflection from the bottom of the ionosphere as being specular. In the analysis presented, using a stratified model of the ionosphere, the ionospheric reflection coefficient is obtained for the case of inhomogeneous anisotropy. The terrestrial magnetic field is superimposed on the upper layer. The results of numerical calculations showed that $||R_\perp||$ is relatively small in comparison to $||R||$, in agreement with the results already obtained for a homogeneous anisotropic model of the ionosphere. No marked changes were observed even when a lower layer was introduced to stratify the ionosphere. However, it was found that changes in the electron density ratio between the upper and lower layers did affect the reflection coefficient below 2 KHz. This tentative treatment seems reasonable for considering the ionospheric reflection of extremely long-wavelength radio waves, and in future research on elf band atmospherics it may serve to explain results of new observations as they are published. (BBB)

1332 ELECTRON IMPACT EXCITATION OF THE DAYGLOW. Dalgarno, A. (Harvard Coll. Observatory, Cambridge, Mass.); McElroy, M. B.; Stewart, A. I. J. Atmos. Sci., 26: 753-62(July 1969).

Fast photoelectrons produced in the upper atmosphere by the absorption of solar uv radiation in ionizing transitions lose energy in collision processes, leading to ionization and excitation of the neutral particles and to heating of the electron and ion gases. The excitation processes produce a substantial component of the dayglow luminosity of the upper atmosphere, which can provide detailed information on the distribution of energy sources in the daytime atmosphere. Calculations are described of the equilibrium velocity distributions of the photoelectrons produced in the F region by solar ionizing radiation. Detailed estimates are presented of the intensities and altitude profiles of emission features of atomic oxygen, molecular nitrogen, and molecular oxygen, appearing in the dayglow as a result of photoelectron impacts. These data are discussed for the 1304, 1356, 8446, 7774, 1026, 1152, 989, 5577, and 6300 Å emission of atomic oxygen, for the dissociative excitation of O_2, first negative system of N_2^+, ir Meinel system of N_2^+, second positive band system of N_2, the first positive band system of N_2, Vegard–Kaplan band system of N_2, Lyman–Birge–Hopfield band system of N_2, and for other band systems. (BBB)

1333 PROPAGATION DUCTS DUE TO HORIZONTAL GRADIENTS LEADING TO ECHOES FROM MAGNETIC FIELD-ALIGNED F-REGION IRREGULARITIES. Dearden, E. W. (Univ. of Queensland, Australia). J. Atmos. Terrest. Phys., 31: 1147-56(Sept. 1969).

A radio wave of frequency just above the MUF may suffer a partial ducting when propagating into an ionospheric layer with a decreasing horizontal gradient of critical frequency. Under suitable conditions this propagation mode could make an appreciable contribution to the observation of direct backscatter from field-aligned irregularities in the F region. (auth) (UK)

1334 SPORADIC-E IONIZATION OVER AHMEDABAD THROUGH THE HALF SOLAR CYCLE 1954–1957. Kotadia, K. M. (Gujarat Univ., Ahmedabad, India). J. Atmos. Terrest. Phys., 31: 1137-46(Sept. 1969).

Characteristic variations of the sporadic-E layer over Ahmedabad are given for the half solar cycle (1953–1957) of increasing sunspot activity. Data of years prior to the IGY were reexamined and brought in uniformity to conform with the recommendations of the AGI/URSI Committee on worldwide ionosphere soundings. Principal features of the three types of E_s that usually occur at Ahmedabad are described and it is shown how each of these three types contributes to the overall variation of sporadic-E ionization. Causes of the ionizations of the different types are discussed. (auth) (UK)

1335 LOW-ENERGY BREMSSTRAHLUNG X-RAY SPECTRA FROM A STABLE AURORAL ARC. Wilson, B. G.; Baxter, A. J.; Green, D. W. (Univ. of Calgary, Alberta). Can. J. Phys., 47: 2427-30(Nov. 1, 1969).

During a rocket experiment launched to investigate cosmic x rays, the directional features and spectral characteristics of x rays from an auroral arc were determined in the 1.6 to 10-keV energy range. The spectrum was best represented by a power law of slope -3.365 ± 0.07. (auth) (Canada)

1336 HORIZONTAL DRIFTS IN THE E AND F REGIONS OVER THUMBA, DURING DAYTIME. Chandra, Harish; Rastogi, R. G. (Physical Research Lab., Ahmedabad, India). J. Atmos. Terrest. Phys., 31: 1205-15(Sept. 1969).

The apparent horizontal drifts in the E and F regions of the ionosphere over Thumba, India (dip. 0.6°S) during the daytime hours of the years 1964–67 are described. The direction of drift is predominantly towards west (about 80% of occasions during any of the seasons of the year). The speed of drift is found to be larger than at any other equatorial stations for which the data are available. The diurnal variation of drift speed in E or F regions shows a forenoon maximum which occurs later during June–July than during other months. There is no distinct change in the drift speed or direction between the years 1964–67. A comparison of drift speed at other stations shows minimum at midlatitudes and a sharp maximum over the magnetic equator. Drift observations at other low-latitude stations are recommended for a detailed study of the abnormal zone near the magnetic equator. (auth) (UK)

1337 INVESTIGATIONS OF ENERGETIC PARTICLES AND RADIATION IN THE POLAR CAP WITH BALLOON-BORNE INSTRUMENTS. Pomerantz, Martin A.; Baird, George A. (Franklin Inst., Philadelphia). Antarctic J. U. S., 4: 122-3(July-Aug. 1969).

Balloon-borne instruments launched near the geomagnetic pole afforded a means of observing in detail, at a specific location, the characteristics and temporal history of enhanced fluxes of energetic x rays generated in the upper atmosphere by electrons, and of γ rays produced by protons with energies below the atmospheric cutoff. Seven flights were conducted at McMurdo Station early in 1969, as the first step in an investigation of particle phenomena in the polar cap with balloon-borne instruments. The instrument packages, carried aloft by 135,000-ft^3 plastic balloons, contained three G–M counters operating singly and in coincidence, and a NaI-crystal scintillator with pulse-height discrimination providing output signals corresponding to x-ray energies >25 keV, >50 keV, >75 keV, >100 keV, and >500 keV. The objective of this program was to carry out a preliminary reconnaissance for

determining the gross characteristics of events occurring deep in the polar cap. Data analysis is still in progress, but preliminary analysis revealed that the noon-midnight ratio is very close to unity, but the possibility that small but significant time variations occurred cannot yet be excluded. Extremely quiet solar conditions prevailed in the brief Antarctic summer during launching of the flights. Therefore, intensity variations were of small magnitude and more difficult to resolve than effects during solar-particle events or during extreme geomagnetic disturbances. (BBB)

1338 CHARACTERISTICS OF THE EXCITATION OF MICROPULSATIONS IN THE SOLAR ACTIVITY CYCLE. Troitskaya, V. A.; Bolshakova, O. V.; Matveeva, E. T.; Shchepetnov, R. V. (Inst. of Terrestrial Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 9: 102-5(1969).

Translated from Geomagn. Aeron., 9: 129-34(1969).

All types of regular and irregular pulsations of the electromagnetic field of the earth in the solar activity cycle are examined. It is demonstrated that the frequency of excitation and the average period and average amplitude of various types of stable pulsations, Pc, vary with a change in the properties of solar corpuscular streams in the cycle. The change in the properties of rapid geomagnetic field pulsations is examined from the viewpoint of the change in the structure of the magnetosphere and in the characteristics of processes taking place in it. (auth)

1339 IONOSPHERIC AERODYNAMICS. Gurevich, A. V.; Pitaevskii, L. P.; Smirnova, V. V. (Lebedev Inst. of Physics, Moscow. Moscow Physical-Technical Inst.). Usp. Fiz. Nauk, 99: No. 1, 3-49(Sept. 1969). (In Russian).

Up-to-date data on ionosphere aerodynamics (the streamline flow of moving objects in rarefied ionosphere plasma) are reviewed. The data are based on actual conditions in the ionosphere at maximum concentrations of charged particles, ion temperature $T_i \sim 1000°K$, and electron temperature $T_e \sim (1 \text{ to } 2.5) \times 10^3°K$. Streamline flow over a half-plane, wedge, rounded edge cylinder, and disk are discussed. The influence of the electric field on moving ions, numerical calculations considering the finite Debye radius, and experimental studies of the perturbation zone in the vicinity of rockets and satellites are covered. 76 references are included. (R.V.J.)

1340 FIELD AND PLASMA IN THE LUNAR WAKE. Whang, Y. C. (Catholic Univ. of America, Washington, D. C.). Phys. Rev., 186: 143-50(Oct. 5, 1969).

A theory is presented to explain the observed variations of the magnetic field and plasma in the vicinity of the moon. Under the guiding-center approximation, solutions for the plasma flow near the moon are obtained from the kinetic equation. The creation of a plasma cavity in the core region of the lunar shadow disturbs the interplanetary magnetic field. Maxwell's equations are used to study perturbations of the magnetic field in the lunar wake. The acceleration drift current, which was omitted from the earlier work, is included in the present theory in the calculation of the total electric current in the lunar wake. Numerical solutions of Maxwell's equations are obtained. When the interplanetary magnetic field lines penetrate into the lunar body, the sudden change in magnetic permeability disturbs the magnetic field at the lunar limbs. Propagations of this disturbance with magnetoacoustic speed form a Mach cone downstream, which is sometimes observed as the exterior increase of field magnitude in the lunar penumbra. Perturbations of the magnetic field are restricted to the region inside the Mach cone; the region outside remains undisturbed. The numerical results agree extremely well with experimental data from the Explorer-35 spacecraft. (auth)

1341 THE OCCURRENCE OF THE N II 4176-A EMISSION LINE IN CONNECTION WITH TYPE-B AURORAS. Gerard, Jean-Claude; Harang, Ove E. (Auroral Observatory, Tromso, Norway). Planet Space Sci., 17: 1680-2(Sept. 1969).

The occurrence of the N II 4176 Å line in the auroral spectrum, its relationship with the low-altitude character of the auroras involved, and its implication on the shape of the energy spectra of secondary electrons are discussed. (UK)

Low-Temperature Physics

Refer also to abstracts 504, 1248, and 1357.

1342 (COO-1569-40) THERMAL FLUCTUATIONS AND THE JOSEPHSON SUPERCURRENT. Anderson, J. T.; Goldman, A. M. (Minnesota Univ., Minneapolis. School of Physics). [1968]. Contract AT(11-1)-1569. 17p. Dep. CFSTI.

Fluctuations can play an important role in determining the behavior of Josephson junctions when the coupling energy across the junction is of the order of thermal energies. This situation can be realized near the critical temperature and near the minima of the $I_1(H)$ curve at low temperatures. In these regimes the effects of thermal fluctuations on the I–V characteristic are quite dramatic. Using a carefully shielded, thermally regulated apparatus, the I–V characteristic of an almost ideal Josephson junction was measured in both of these regimes. The results are in qualitative agreement with calculations which treat the problem of thermal fluctuations in a junction, using an analogy with the Brownian motion of a particle in a field of force. (auth)

1343 (COO-1569-51) THEORY OF BINARY BOSON SOLUTIONS. Massey, Walter E. (Illinois Univ., Urbana. Dept. of Physics); Woo, Chia-Wei (Northwestern Univ., Evanston, Ill. Dept. of Physics. Argonne National Lab., Ill.); Tan, Hing-Tat (Minnesota Univ., Minneapolis. School of Physics and Astronomy). [1969]. Contract AT(11-1)-1569. 28p. Dep. CFSTI.

The properties of a dilute solution of mass-3 bosons in liquid ^{4}He at low temperatures are computed via a variational procedure. A set of coupled integro–differential equations is solved, yielding the ground-state energy per particle, the binding energy of ^{3}He in ^{4}He, the volume excess parameter α, the (3,3), and (4,4) distribution functions, and the long-wavelength limit of the effective interaction between ^{3}He quasi particles in ^{4}He. Results compare favorably with experiment and with phenomenological theories. (auth)

1344 SOME SUPERCONDUCTING PROPERTIES OF Ti–Nb–Ta TERNARY ALLOYS. Suenaga, M.; Ralls, K. M. (Univ. of California, Berkeley). J. Appl. Phys., 40: 4457-63(Oct. 1969).

Superconducting properties of the ternary system Ti–Nb–Ta were measured. Critical temperatures were found to decrease with increasing amount of Ta in the alloys from those of Ti–Nb binary alloys. However, a broad plateau of high critical fields (above 120 kG) was observed in the region around the composition 63 at.% Ti–31 at.% Nb–6 at.% Ta. This plateau is discussed in relationship with the corrected Abrikosov upper critical field and with the Maki upper critical field which includes the effects of Pauli paramagnetism and spin–orbit scattering. Critical current density data are also reported for one alloy. (auth)

1345 EFFECT OF PRESSURE ON THE SUPERCONDUCTING TRANSITION TEMPERATURE. Sikora, P. T. (Atomic Energy Research Establishment, Harwell, Eng.). Phys. Lett., 30A: 158-9(Oct. 6, 1969).

The volume dependence implicit in the Morel–Anderson prescription for the superconducting transition temperature is calculated. The resulting expression for the pressure shift of the coupling constant depends only on basic properties and is in reasonable agreement with experiment. (auth)

1346 SPECIFIC HEAT AND SUPERCONDUCTIVITY OF Nb-BASED A15-TYPE COMPOUNDS. Spitzli, P.; Fluekiger, R.; Heiniger, F.; Muller, J. (Univ., Geneva). Phys. Lett., 30A: 170-1(Oct. 6, 1969).

The band structure density of states and the electron–phonon coupling parameter have been determined from measurements of the low temperature specific heat for Nb_3Os, Nb_3Ir, and Nb_3(Pt, Au). Both are found to be sensitive to the state of order in the Nb_3(Pt, Au) system. (auth)

1347 CRITICAL BEHAVIOUR OF THE RESISTANCE NEAR THE SUPERCONDUCTING PHASE TRANSITION. Sapir, M. (Technion–Israel Inst. of Tech., Haifa). Phys. Lett., 30A: 197 (Oct. 6, 1969).

It is pointed out that critical behavior of the resistance is expected to appear when the temperature is lowered because of the formation of an intermediate state. (auth)

1348 THE EFFECT OF GRAIN SIZE ON THE SUPERCONDUCTING TRANSITION TEMPERATURE OF THE TRANSITION METALS. Hanak, J. J.; Gittleman, J. I.; Pellicane, J. P.; Bozowski, S. (Radio Corp. of America, Princeton, N. J.). Phys. Lett., 30A: 201-2(Oct. 6, 1969).

Grain-size reduction depresses T_c of α-La and enhances T_c of bcc Mo. Consistency with phonon-mediated electron pairing requires a grain-size dependence of the quantity $N(0)\langle I^2\rangle$. (auth)

1349 PRESSURE EFFECT ON THE MAGNETIC PROPERTIES OF SUPERCONDUCTING LANTHANUM. Takata, M. (Osaka Univ.). Phys. Lett., 30A: 244-5(Oct. 20, 1969).

From the pressure dependence of the critical field of dhcp La, the change of the density of states at the Fermi level N(0) with volume, $d \ln N(0)/d \ln v$, was calculated. It ranges from −2.0 to −2.2. (auth)

1350 PROCEEDINGS OF THE Xth INTERNATIONAL CONFERENCE ON LOW TEMPERATURE PHYSICS, MOSCOW, USSR, AUGUST 31–SEPTEMBER 6, 1966. VOLUME I. PROPERTIES OF HELIUM. Pitaevskii, L. P.; Anufriev, Yu. D. (eds.). Moscow, Publishing House of All-Union Research Institute of Technology, 1967. 552p. (In Russian and English). (CONF-660816).

This volume includes eighty invited papers and nine abstracts of invited papers on various properties of liquid and solid helium. Of the eighty papers, sixty-six are in English and fourteen in Russian; four of the nine abstracts are in English, five in Russian. The opening address by P. L. Kapitza is included (in Russian), as well as the presentation address for the fifth Fritz London Award (in English by Henry A. Boorse) to Professor C. J. Gorter. Separate abstracts were not prepared for any of the papers because of the time elapsed since their presentation. (L.M.T.)

1351 EVAPORATION FROM SUPERFLUID HELIUM. Hyman, David S. (Massachusetts Inst. of Technology, Cambridge); Scully, Marlan O.; Widom, Allan. Phys. Rev., 186: 231-8(Oct. 5, 1969).

A simple theory of evaporation from liquid He II is constructed, and it is used to analyze the experimental results of Johnston and King on the velocity distribution of atoms evaporating from He II at low temperatures. The theory suggests that rotons are responsible for shifting the velocity distribution to energies ≈1.5°K, in good agreement with experiment. However, multi-excitation processes are needed to explain the complete velocity distribution at high energies. Two new experiments are proposed that would test the model and provide new information concerning excitations in liquid helium. (auth)

1352 MICROWAVE-ENHANCED SUPERCURRENT ACROSS A JOSEPHSON JUNCTION IN THE PRESENCE OF A MAGNETIC FIELD. Gregers-Hansen, P. E.; Levinsen, M. T. (Univ. of Copenhagen). Solid State Commun., 7: 1215-18 (Sept. 1969).

Microwave radiation in the presence of a weak magnetic field is under certain conditions observed to increase the maximum supercurrent of a Josephson junction. These observations are probably due to translational vibration of the linear vortex structure in the junction. (auth) (UK)

1353 TEMPERATURE DEPENDENCE OF H_{c3}/H_{c2} IN PURE TYPE-II SUPERCONDUCTORS. Ebner, C. (Ohio State Univ., Columbia). Solid State Commun., 7: 207-10(Sept. 1969).

Numerical solutions of the gap equation for surface superconductivity in pure materials with specular reflection are given for $T \lesssim 0.9\ T_c$. The results show a smooth monotonic decrease of H_{c3}/H_{c2} as T rises. The shape of the gap parameter was also determined. (auth) (UK)

1354 COHERENT STATES IN SUPERFLUIDS. Johnston, James Rea. Riverside, Calif., Univ. of California, 1968. 153p. Thesis.

The macroscopic quantum effects which make superfluidity such an intriguing subject can be described by assuming that the average of the particle field operator $\psi(x)$ is nonzero. A quasi-particle model for liquid helium is presented which is an extension of the pair model of Girardeau and Arnowitt designed to give a nonzero average to $\psi(x)$. The justification for this model is based on analogies with coherent radiation fields and the concept of off-diagonal long-range order (ODLRO). The subject is introduced by a short description of some of the unusual properties of superfluid helium and the description of macroscopic quantum effects (in superconductors as well as helium) in terms of number and phase. The quantum description of coherence in radiation fields is reviewed and a toy model for "signal-plus-noise" presented. An introduction to the use of density operators and reduced density operators is given in order to develop the concept of ODLRO. A new quasi-particle model for liquid helium is presented in which the expectation value of $\psi(x)$ is nonzero. This model has the form of signal-plus-noise. The equation of motion of ψ in this model gives a Gross–Pitaevskii equation modified by depletion terms. The model suffers from the fact that while $\langle\psi(x)\rangle$ is not translationally invariant, the depletion terms are. If the interaction potential is approximated by a point-contact potential, the effect of the depletion terms is essentially the renormalization of the chemical potential in the Gross–Pitaevskii equation. Finally, local number fluctuations for a condensed and a noncondensed ideal Bose gas in a sharp-number quantum state are investigated in order to better understand the rationale for the breaking of number conservation required to allow nonzero expectation values for $\psi(x)$. (Disser. Abstr.)

1355 ORIGIN OF LOW-VOLTAGE STRUCTURE AND ASYMMETRY IN THE I–V CHARACTERISTICS OF MULTIPLY CONNECTED SUPERCONDUCTING JUNCTIONS. Clarke, J. (Univ. of California, Berkeley); Fulton, T. A. J. Appl. Phys., 40: 4470-6(Oct. 1969).

A self-magnetic field effect is shown to be responsible for much of the low-voltage structure and for asymmetries observed in the I–V curves of superconducting niobium-solder junctions (Slugs). Similar effects are to be expected in other multiply-connected junctions. (auth)

1356 AC LOSSES IN TYPE-I SUPERCONDUCTORS IN THE MEISSNER STATE. Seebold, R. J. A.; Rhodes, R. G. (Univ. of Warwick, Coventry, Eng.). J. Phys., D (London), 2: 1463-6(Oct. 1969).

Results are given for the ac surface loss in pure lead and type I lead–indium alloys when the peak value of the alternating applied magnetic field is less than H_c, i.e., the Meissner state. Measurements were performed by a watt-meter technique on short cylindrical samples and show that loss per cycle is reduced with improved surface profile and is independent of normal-state resistivity and magnetic field frequency. (auth) (UK)

1357 MACROSCOPIC COHERENCE AND SUPERFLUIDITY. Anderson, P. W. (Cambridge Univ., Eng.). pp 47-54 of Contemporary Physics: Trieste Symposium 1968. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.1); CONF-680629(Vol.1).

The problem of the coherence in a superfluid, namely a substance which possesses ODLRO in the Yang sense, is treated, with a particular account of the problem of dissipation in the superfluid. The relation between dissipation and quantized vortices is also explained, both for superfluids and superconductors. (auth)

1358 MICROSCOPIC THEORY OF SUPERCONDUCTIVITY. Schrieffer, J. R. (Univ. of Pennsylvania, Philadelphia). pp 55-69 of Contemporary Physics: Trieste Symposium 1968. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.1); CONF-680629(Vol.1).

Topics covered are weak-coupling pairing theory, excitation spectrum, coherence effects, strong-coupling superconductivity, ferromagnetism and superconductivity, and nonphononic mechanisms. (auth)

1359 KINETIC PHENOMENA IN SUPERCONDUCTORS. Gellikman, B. T.; Kresin, V. Z. (Kurchatov Inst. of Atomic Energy., Moscow. Moscow State Correspondence Teacher's Inst.). Usp. Fiz. Nauk, 99: No. 1, 51-86(Sept. 1969). (In Russian).

Kinetic phenomena in superconductors are briefly reviewed, limited to thermal conductivity and acoustic damping. The main features of superconductors are expressed by the presence of a condensate of Cooper pairs in motion without any entropy transfer. The number of electron excitations, which play an important role in the kinetic phenomena, is a function of the temperature and is decreased with a decrease in T_c (the critical temperature) and approaches zero as the temperature $T \to 0$. Such dependence of the number of carriers on the temperature and corresponding variation of the mean free path result in the unique kinetic phenomena which are analyzed. 160 references. (R.V.J.)

1360 THEORY OF BOSE–FERMI QUANTUM LIQUIDS. Khalatnikov, I. M. (Inst. for Theoretical Physics, Moscow). pp 71-86 of Contemporary Physics: Trieste Symposium 1968. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.1); CONF-680629(Vol.1).

A phenomenological theory of a mixture of Fermi and Bose liquids is presented here, similarly to Landau's procedure for Fermi liquids. A definition is given for the Fermi excitation energy in a superfluid liquid. An exact set of equations has been obtained which describes the properties of a Fermi–Bose liquid; the solutions in the acoustic range are discussed. (auth)

1361 GRAVITY-INDUCED ELECTRIC FIELDS IN SUPERCONDUCTORS. Papini, G. (Univ. of Saskatchewan, Regina). Nuovo Cim., 63B: 549-59(Oct. 11, 1969).

Relativistic effects of order v^2 cannot, in general, be neglected in the calculation of rotation-induced electric fields within superconductors of the first kind. They give rise to the London fields recently detected and to fields comparable in magnitude with those calculated by De Witt (Phys. Rev. Lett., 16: 1092(1966)). (auth)

1362 THE SUPERCONDUCTING TRANSITION TEMPERATURES OF DISORDERED Nb, W, AND Mo FILMS. Crow, J. E.; Strongin, M.; Thompson, R. S.; Kammerer, O. F. (Brookhaven

National Lab., Upton, N. Y.). Phys. Lett., 30A: 161-2(Oct. 6, 1969).

Large changes in T_c were observed in films of Nb, W, and Mo evaporated under ultrahigh vacuum conditions onto cryogenic substrates. An explanation of these temperature changes in terms of the smearing of N(0) due to the small mean free path is discussed. (auth)

1363 INFLUENCE OF THERMAL PROCESSES ON THE KINETICS OF THE DESTRUCTION OF SUPERCONDUCTIVITY BY CURRENTS. Smirnov, A. P.; Parshina, I. S.; Rusanova, T. A.; Totubalin, V. N. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekh. Fiz., 38: 1588-95(Sept. 1968). (In Russian).

The influence of Joule heat, released when superconductivity in film samples is destroyed by current, on the development of the intermediate state is investigated. Different methods (thermometry of the samples, registration of pressure waves in helium, visual observation of the heat release as revealed by the boiling of the helium on the surface of the sample) are used to show that, starting with a certain heat-release rate, an intense cooling of the surface sets in, due to processes of evaporative cooling. The main heat transfer is effected in the helium and depends strongly on the temperature, reaching a maximum at the λ point. The features of the heat transfer in the liquid helium are determined by many processes characteristic of the kinetics of the destruction of superconductivity by current (oscillations of resistance, nonmonotonic character of the change of resistance with current, and others), as well as the temperature variation of the critical current. (ATD)

1364 PHONON–QUASIPARTICLE INTERACTIONS IN DILUTE SOLUTIONS OF ^{3}He IN SUPERFLUID ^{4}He. Saam, William Frederick. Urbana, Ill., Univ. of Illinois, 1968. 138p.

Thesis.

Both the nature of phonon–quasiparticle interactions in dilute solutions of ^{3}He in superfluid ^{4}He and the role they play in determining the linear response properties of such solutions are examined. The vertices for phonon scattering and absorption by ^{3}He quasiparticles as well as the effective interaction between quasiparticles are discussed from the microscopic theory. Much of the previous semi-phenomenological theory concerning these quantities is justified. The properties of a dilute gas model for dilute solutions are worked out to first order in the gas parameter, the results provide an example and a check for the general theory. Using the phonon–quasiparticle vertices a phonon Boltzmann equation is developed. This equation is completely soluble in the absence of rotons and phonon–phonon interactions, and it is used in conjunction with the quasiparticle Boltzmann equation and the superfluid equation of motion to determine the attenuation of both first and second sound and the kinetic coefficients in dilute solutions. There is good overall agreement with available experimental results for first sound attenuation. (Disser. Abstr.)

1365 ON THE GENERATION OF QUANTIZED VORTICES IN LIQUID ^{4}He II. Hyland, G. J.; Rowlands, G. (Univ. of Warwick, Coventry, Eng.). Phys. Lett., 30A: 222-3(Oct. 20, 1969).

The possibility of generation of quantized vortices in liquid He II, via interaction between the superfluid and normal components, is demonstrated on the basis of a macroscopic wave equation recently derived by Fröhlich. (auth)

1366 QUANTUM THEORY OF SUPERFLUID VORTICES. III. INELASTIC PHONON SCATTERING. Fetter, Alexander L. (Stanford Univ., Calif.). Phys. Rev., 186: 128-43(Oct. 5, 1969).

The quantum theory of vortex waves is used to study phonon scattering by a vortex in He II. If the scattering amplitude is expanded in the number of quanta of vortex waves emitted or absorbed, the resulting inelastic amplitude diverges at long wavelengths. Inclusion of inelastic effects to all orders avoids this unphysical behavior and yields a differential cross section essentially equal to that for elastic phonon scattering. (auth)

Plasma and Thermonuclear Physics

1367 PLASMA PHYSICS INDEX. Volume 4, No. 8, 1969. Bibliography, Author Index, Subject Index. Frankfurt am Main, Zentralstelle fuer Atomkernenergie-Dokumentation, 1969. 259p.

500 references on various aspects of plasma and thermonuclear research are listed. (M.O.W.)

1368 PLASMA PHYSICS: TECHNOLOGY INDEX. Volume 3, No. 8. Bibliography, Author Index, Subject Index, Appendix. Frankfurt am Main, Zentralstelle fuer Atomkernenergie-Dokumentation, 1969. 93p.

187 articles on technology associated with plasma physics are listed. Papers on superconductivity and laser technology are included. (M.O.W.)

Confinement and Heating

1369 PLASMA HEATING BY AN ELECTRON BEAM PRODUCED IN A TURBULENT LINEAR DISCHARGE. Karchevskii, A. I.; Averin, V. G.; Bezmel'nitsyn, V. N. JETP Lett. (USSR) (Engl. Transl.), 10: 17-23(July 5, 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu, 10: 26-30(July 5, 1969).

It can be assumed that one of the explanations of the strong plasma heating observed in several earlier experiments is the excitation of a beam of accelerated electrons in the linear discharge, and the subsequent interaction of this beam with the cold plasma. This letter reports on an attempt to verify this assumption with an experiment on plasma heating in a magnetic mirror trap ("probkotron") by an electron beam generated by a linear discharge and passing through the anode. The experiment was performed with the "Aspa" setup described previously (Sov. Phys.–JETP, 26: 1(1968)). (L.M.T.)

1370 EFFECT OF THE ELECTROMAGNETIC FIELD CREATED BY EXTERNAL CURRENTS ON PLASMA DENSITY DISTRIBUTION. Demchenko, V. V.; Dolgopolov, V. V. (Kharkov State Univ.). Ukr. Fiz. Zh., 14: 209-12(Feb. 1969). (In Russian).

Density distribution of confined plasma due to the electromagnetic field produced by external modulated currents was studied. Expressions for the fields and plasma densities were obtained for the case of plane-parallel layers of plasma and for those when the cylindrically symmetric plasma is confined by the electromagnetic field produced by external azimuthal current flowing through the cylinder surface. (auth)

1371 CHARACTERISTICS OF TOROIDAL HELIOTRON P FIELD. Mohri, Akihiro (Kyoto Univ.). Kakuyugo Kenkyu, 23: No. 4, 231-47(Aug. 1969). (In Japanese).

An average minimum-B field of a toroidal configuration for plasma confinement can be produced by immersing current-carrying ring conductors in a toroidal magnetic field. The rings encircle the minor axis of the torus. Owing to the toroidal effect, positions of null-field lines, separatrix, and the magnetic axis all shift from their original positions in case of the linear configuration. These deviations are examined with a digital computer as a function of the ring current over the wide range of the geometrical parameters such as the aspect ratio (6-64) and number of the rings (4 ~ 64). Average magnetic wells are formed around the separatrix and also local magnetic shear appears due to the toroidal effect. Equipotential surfaces defined by $\oint dl/B = \text{const.}$ close themselves, except those far from the minor axis of the torus. The critical surface where $\delta\oint dl/B = 0$ exists in the bad region of the torus and it does not coincide with the equipotential surface. (NSA of Japan)

1372 TURBULENT DIFFUSION OF A PLASMA ACROSS A MAGNETIC FIELD. Tchen, C. M. (City Univ. of New York). pp 47-54 of Turbulence of Fluids and Plasmas. Fox, Jerome (ed.). Brooklyn, Polytechnic Press of the Polytechnic Inst. of Brooklyn, 1969.

From Symposium on Turbulence of Fluids and Plasmas, New York. See CONF-680431.

A plasma in a turbulent state is considered. A constant magnetic field is present. The turbulent medium is provided by the irregular electrostatic field motions. In such a medium, it is supposed that a particle (ion) is immersed and moves according to a generalized Langevin equation of motion. The particle diffusion in the physical space, as dependent on the correlation of velocities, is related to the correlation of electric fields through the Langevin equation. On the other hand, the correlation of electric fields is studied by means of a turbulent theory of eddy diffusion by electrostatic fluctuations in the momentum space and in the Lagrangian description. The latter theory, called "cascade theory," has been successful in the derivation of the $k^{-\frac{5}{3}}$ law of the plasma density spectrum by the author. A similar approach is applied here, and the diffusion by electrostatic fluctuations and its dependence on the magnetic field, the turbulent intensity of electrostatic fluctuations, and the turbulent vorticity are derived. As the fundamental result, the particle diffusion is obtained as a function of the magnetic field, the turbulent kinetic energy, and the ratio of two relaxation times (collisional and turbulent). Although the theory also gives the laminar diffusion, the turbulent diffusion is more interesting. The latter is (a) inversely proportional to ω_c, the cyclotron frequency, in agreement with the Bohm diffusion, and (b) proportional to the square root of the turbulent kinetic energy, rather than the turbulent kinetic energy to its first power. This curious fact, not pres-

ent in other theories on anomalous diffusion, seems to be noticeable in recent experiments. The two features (a) and (b) can be represented by a turbulent Larmor radius l_c. The turbulent vorticity introduces a turbulent microscale of length λ, representative of the relaxation by turbulent dissipation. Finally, the basic collisional relaxation time being τ, the turbulent diffusion is found to be $D_E = l_c \lambda/2\tau$, as opposed to the laminar diffusion $D_X = L_c^2/2\tau$, also found in the theory, where L_c is the laminar Larmor radius. The turbulent diffusion in the absence of a magnetic field is also considered. The ratio between the two diffusions, with and without a magnetic field, characterizes the eccentricity in the growth of a plasma cloud, initially spherical and released in a magnetic field in the upper atmosphere. The observational data seem to follow the turbulent law of eccentricity $(\omega_c\tau)^{-1}$, instead of the laminar law $(\omega_c\tau)^{-2}$. It is to be remarked that the Langevin equation, taken as a basis of the present theory, is a simplification related to a random walk whose characteristic time is the collision time. Consequently, the ratio of the kinetic energy to the said time scale determines a rate of dissipation, which is a constant physical parameter attached to the random process, and which perpetually evolves in the derivations and results. If the process is not collisional, a new time scale representative of the collisionless dissipation should be substituted. Such a modification is also suggested in the theory. (auth)

1373 CONTROLLED THERMONUCLEAR RESEARCH. Thompson, W. B. (Univ. of California, La Jolla, San Diego). pp 237-48 of Contemporary Physics: Trieste Symposium 1968. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.1); CONF-680629(Vol.1).

The discussion is given in the following order: introduction; energetic considerations; nuclear energy release; containment times; radiation losses (bremsstrahlung), synchrotron radiation, electron temperature, and transparency; merits of fusion reactors; plasma confinement; and microinstabilities. (M.O.W.)

1374 PROBLEM OF PLASMA CONFINEMENT. Coppi, B. (Inst. for Advanced Study, Princeton, N. J. Princeton Univ., N. J.). pp 249-56 of Contemporary Physics: Trieste Symposium 1968. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.1); CONF-680629(Vol.1).

An elementary presentation of the problems overcome and to be solved in the process of understanding the collective effects that determine the dynamics of low-density plasmas in strong magnetic fields is given. The agreement between theory and experiments that appears to characterize a new phase of this field of research is pointed out. (auth)

1375 EFFECT OF INERTIA ON LOSSES FROM A PLASMA IN TOROIDAL EQUILIBRIUM. Zehrfeld, H. P.; Green, B. J. (Institut fuer Plasmaphysik, Garching, Ger.). Phys. Rev. Lett., 23: 961-4(Oct. 27, 1969).

The magnetohydrodynamic equilibrium of a resistive, low-density plasma in a model stellarator field is investigated. The effect of inertia on plasma motion is treated exactly, and its influence on plasma loss determined. It is shown that the losses due to inertia are limited by the conditions for the existence of an equilibrium. (auth)

Diagnostics

Refer also to abstract 508.

1376 CHARACTERISTICS OF MULTI-ELECTRODE PROBE FOR MEASURING RAREFIED PLASMA. Skvortsov, V. V.; Nosachev, L. V.; Netsvetailov, E. M. Kosm. Issled., 7: 415-24 (May-June 1969). (In Russian).

A multi-electrode probe was used for studying electron and ion components of rarefied plasma created by an ion source. A qualitative explanation is given of the various characteristics of the multi-electrode probe. Measurements of flux parameters by the probe were correlated with similar measurements obtained by means of single plane probes. (tr-auth)

1377 EXPERIMENTAL STUDY OF DISTRIBUTION FUNCTIONS OF A PROBE WITH ELECTROSTATIC SEPARATION. Bussac, J.-P.; Frank, R.; Weisse, J. (CEN, Saclay, France). J. Phys. (Paris), 30: 551-5(July 1969). (In French).

An electrostatic analyzer that separates the Langmuir probe current into its ionic and electronic components was used. In order to obtain sufficient accuracy, effects that can perturb the measurements are examined. Using this result, one tries to avoid instabilities and to measure diffusion related to other kinds of instabilities. Then the distribution functions of the plasma were measured. (auth)

1378 RADAR INTERFEROMETRY MEASUREMENTS OF THE PROPERTIES OF A TURBULENT PLASMA. Weissman, D. E.; Guthart, H.; Morita, T. (Stanford Research Inst., Menlo Park, Calif.). pp 251-79 of Turbulence of Fluids and Plasmas. Fox. Jerome (ed.). Brooklyn, Polytechnic Press of the Polytechnic Inst. of Brooklyn, 1969.

From Symposium on Turbulence of Fluids and Plasmas, New York. See CONF-680431.

Radar interferometry is a diagnostic technique for the remote probing of the parameters of a turbulent plasma. A laboratory experiment has been conducted that demonstrates the applicability of radar interferometry to the measurement of the spatial distribution of the incoherent electromagnetic power backscattered from a turbulent plasma column. Three interferometer techniques have been used to measure the spatial correlation of the x-band electromagnetic fields, an intensity interferometer, as well as two phase and amplitude interferometer techniques. One of the latter was a microwave version of the Michelson stellar interferometer, and the other employed homodyne detection to preserve the relative phase information. The measurements of the spatial correlation are in good agreement with a function derived theoretically by using extensive diagnostic data and the Born approximation to calculate the scattered power. (auth)

1379 FUNDAMENTAL PROCESSES IN NONEQUILIBRIUM CESIUM PLASMA. Inoue, T.; Oshitani, K. (Nagoya Univ., Japan). Denki Gakkai Zasshi, 89-4: 711-20(Apr. 1969). (In Japanese).

Electron density, electron temperature, and the steady-state electric field in nonequilibrium cesium plasma were analyzed quantitatively in terms of collisional and radiative processes taking place in the plasma. For this purpose, generating rate equation, equation of motion, and energy equation were expressed using cross section or frequency for each process. Combining these equations for neutral atoms, excited atoms, ions, and electrons, one obtains electron density, density of excited atoms, and steady-state electric field as functions of electron temperature. Numerical calculation was made, and the results were illustrated and compared with measurements made at relatively low pressure of 10^{-3} to 1 torr and with discharge current below 1.6 A. For pressures of 0.05 to 1 torr, the relations of electron density and steady-state electric field to electron temperature, deduced from the collisional–radiative model, showed better agreement than that for the local thermal-equilibrium model. For lower pressure, mean free path exceeded the tube diameter. (NSA of Japan)

1380 HALL-CURRENT CHARACTERISTIC IN PLASMA IMMERSED IN STRONG MAGNETIC FIELD. Nagata, Mitsuaki (Meiji Univ., Tokyo). Denki Gakkai Zasshi, 89-3: 493-8(Mar. 1969). (In Japanese).

Plasma measurement utilizing Hall current was applied to the measurement of attenuation of electrical conductivity due to a strong magnetic field. The test plasma was produced by cold-cathode discharge in Ne gas at pressures of 6, 3, 1.5 mm Hg, with current of 10 mA. A strong magnetic field of 0 to 600 gauss was applied parallel to the discharge tube with a Helmholtz coil. Another Helmholtz coil provided a superposing weak field perpendicular to the tube, to produce the Hall effect. The Hall current was measured with two disc probes, which also measured ion current to correct for density change due to a strong magnetic field. Attenuation of Hall current, corrected for the density change, was smaller than that given by the classical theory, $1/(1 + \omega_c^2\tau^2)$, where ω_c is the cyclotron frequency and τ is the mean free time of electrons. Various causes of this discrepancy were discussed, such as errors of measurement, effect of transition layer and anode oscillation, but none gave an adequate explanation. A sketch of a theory which may lead to the correct explanation was given. (NSA of Japan)

1381 VISIBLE LIGHT EMISSION FROM NONEQUILIBRIUM CESIUM PLASMA. Oshitani, K.; Inoue, T. (Nagoya Univ., Japan). Denki Gakkai Zasshi, 89-4: 721-9(Apr. 1969). (In Japanese).

Spectral intensity distribution of the visible light from the cesium plasma at vapor pressure below 1 torr and with discharge current below 1.6 A, was measured with a plane-grating monochromator of resolving power 3Å. At low pressure, line spectra dominate, but at pressure of about 1 torr, continuous spectra appear, and both the line spectra and the continuous spectra increase in intensity with increasing pressure and discharge current. Intensity of the line spectra for principal series showed marked effect of self-absorption. From the self-absorption, escape probability was calculated and illustrated. Dependence of the line intensity on pressure was analyzed quantitatively in a collisional–radiative model, applicable to the intermediate region between those for the thermal equilib-

rium and corona equilibrium models. Density of excited atoms was estimated, and the luminous efficiency defined by the ratio of power of visible emission to electrical input, was obtained. (NSA of Japan)

1382 CORRELATION STUDY IN NEUTRAL-DOMINATED PLASMA TURBULENCE. Johnston, T. W.; Richard, C.; Ghosh, A. K.; Carswell, A. I.; Graf, K. (Radio Corp. of America Victor Co., Ltd., Montreal). pp 65-85 of Turbulence of Fluids and Plasmas. Fox, Jerome (ed.). Brooklyn, Polytechnic Press of the Polytechnic Inst. of Brooklyn, 1969.

From Symposium on Turbulence of Fluids and Plasmas, New York. See CONF-680431.

Detailed measurements of space–time plasma probe correlation functions are discussed for probe measurements of electron density fluctuations in a dc arc-jet plasma using argon. The probe axial wave number frequency spectral function is considered, and it is deduced that even for fairly large velocity fluctuations (~20%) the Taylor hypothesis is quite adequate. (auth)

1383 RETARDATION METHOD FOR PLASMA MEASUREMENTS. Bakulin, E. A.; Stepin, E. V.; Shcherbinina, V. V. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 77-82(July 1969).

Translated from Zh. Tekh. Fiz., 39: 114-21(Jan. 1969).

Several features of the use of a multi-electrode probe in a gas-discharge plasma with no magnetic field are discussed. The effects of neutral pressure, probe geometry, space charge, and electrode surface contamination on the I–V characteristics are examined. (auth)

1384 MULTI-ELECTRODE PROBE FOR NEGATIVE POTENTIALS RELATIVE TO A PLASMA. Bakulin, E. A.; Bredov, M. M.; Stepin, E. V.; Shcherbinina, V. V. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 73-6(July 1969).

Translated from Zh. Tekh. Fiz., 39: 108-13(Jan. 1969).

In order to study plasmas with multi-electrode probes it is often necessary to measure the plasma parameters using negative probe potentials relative to the plasma. It is shown that the volt–ampere characteristics taken with the use of a multi-electrode probe can be considerably distorted due to the microoptics of the electrode in contact with the plasma. This distortion can be reduced by proper choice of the potential difference between the probe electrodes. (auth)

1385 DETERMINATION OF ELECTRON DENSITY IN PLASMA JETS USING A MICROWAVE FABRY–PEROT INTERFEROMETER AND THE STARK EFFECT. Odintsova, G. A.; Vaulin, E. P. (Moscow Aviation Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 68-72(July 1969).

Translated from Zh. Tekh. Fiz., 39: 102-7(Jan. 1969).

Measurements of electron density in stationary plasma jets composed of argon and mixtures of argon and helium were made using a microwave Fabry–Perot interferometer (λ = 8 mm) and the Stark broadening of the hydrogen H_β line. Curves showing density as a function of gas flow rate obtained by both methods are in good agreement. The study showed that the microwave Fabry–Perot interferometer can be used to measure the density of low-density plasma jets. The two methods can be used to measure densities over a wide range. (auth)

1386 CERTAIN PROBLEMS IN CALCULATING THE TEMPERATURE OF ac ARCS. Uraev, V. P. (Moscow Power Engineering Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 54-60(July 1969).

Translated from Zh. Tekh. Fiz., 39: 82-92(Jan. 1969).

The energy balance equation for the positive column of a free ac arc is considered under the assumption of cylindrical symmetry of the current-conducting arc column, whose cross section is assumed to be uniform. This equation is integrated for the case of a sinusoidal arc current. With these assumptions, the time dependences of the temperature at the axis of a sinusoidal ac arc and the relationships determining the temperature variation over the cross section of the current-conducting zone of the arc are derived. (auth)

1387 ELECTROSTATIC-PROBE STUDIES IN A FLAME PLASMA. Clements, R. M.; Smy, P. R. (Univ. of Alberta, Edmonton). J. Appl. Phys., 40: 4553-8(Oct. 1969).

Simple theoretical considerations have yielded an approximate formula for the ion current per unit length I_i to a cylindrical probe (radius r_p, bias voltage V) immersed in a collision-dominated moving plasma. This relation has been checked with a propane/air flame and a moving probe; it is found to be correct within ±50% over several decades of probe voltage, probe-flame velocity and flame ionization. A more favorable choice of μ_i (ion mobility) in the above expression improves the agreement between theory and experiment to ±30%. Measurements of sheath thickness obtained from the mutual interference of two adjacent probes support the basic tenets of the theoretical model. It is concluded that, in many instances of probe measurements in flames and other collision-dominated plasmas, the velocity-dependent approach adopted in this paper will be necessary since very large errors can arise if the usual static continuum plasma formulas are used. (Errors of up to a factor of 100 have been reported.) (auth)

1388 THIN CYLINDRICAL ANTENNA IN AN ISOTROPIC PLASMA. Andronov, A. A.; Eidman, V. Ya. Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 267-72(Aug. 1969).

Translated from Zh. Tekh. Fiz., 39: 365-71(Feb. 1969).

An analysis is made of the penetration of an electric field into a homogeneous plasma at frequencies ω near the plasma frequency ω_0. An integral equation is obtained for the current at the surface of a thin cylindrical antenna in the homogeneous plasma and it is shown that the input impedance of an antenna whose dimensions are large compared with the Debye radius, for $\omega = \omega_0$, depends only on the antenna gap. (auth)

1389 PLASMA DIAGNOSTICS IN A PINCH-DISCHARGE LASER. Vasil'eva, A. N.; Likhachev, V. M.; Sutovskii, V. M. (Lebedev Inst. of Physics, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 246-50(Aug. 1969).

Translated from Zh. Tekh. Fiz., 39: 341-6(Feb. 1969).

The parameters of the plasma in a pinch-discharge laser were investigated using spectroscopic methods. The electron temperatures were also determined from the plasma conductivity. The measurements were made with the required time and spatial resolution. (auth)

1390 INTERELECTRODE PROCESSES IN A TENUOUS PLASMA STREAM WITH A BOUNDARY LAYER. Chekalin, E. K.; Watson, A. M. (Krzhizhanov Energy Inst., Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 41-5(July 1969).

Translated from Zh. Tekh. Fiz., 39: 64-70(Jan. 1969).

Experimental results are presented of an investigation into the volt–ampere characteristics of a stationary argon plasma stream at low pressure ($p \simeq 0.5$ torr) using several pairs of cold electrodes located on the walls of the tube parallel to the stream. The dependence on the location of the electrodes is studied. It is shown that with increasing boundary layer thickness the down-stream current saturation decreases abruptly. The experimental results agreed with theoretical calculations based on measured values of electron temperature, electron density, stream velocity on the axis of the tube, and plasma stream pressure. The experimentally measured saturation current is in satisfactory agreement with theory. This study was performed at Oxford (England) in the engineering department of Oxford University during 1965–1966. (auth)

1391 EQUIVALENT EXCITED-STATE TEMPERATURE OF A HIGH-PRESSURE PLASMA IN WHICH THE ELECTRON TEMPERATURE EXCEEDS THE GAS TEMPERATURE. Collins, C. B. (Southwest Center for Advanced Studies, Dallas). Phys. Rev., 186: 113-16(Oct. 5, 1969).

The modulus of the distribution among quantum levels of the excited-state population resulting from the recombination of ions and electrons in a hypothetical heliumlike plasma at high pressure is calculated for cases of unequal electron and gas temperatures. Both neutral-collision-induced and electron-collision-induced processes are considered for electron densities from 10^8 to 10^{13} cm^{-3}, gas densities from 10^{16} to 10^{19} cm^{-3}, and electron temperatures from 300 to 2000°K. The effective temperature of the bound electrons in the highly excited states is found to lie between the electron and neutral-gas temperatures, passing to the former in the limit of low neutral density and to the latter in the limit of high neutral density. (auth)

Kinetics (Experimental)

1392 MEASUREMENT OF THE ABSOLUTE TRANSITION OF Ar I LINES. Wujec, T. (Higher School of Pedagogy, Opole, Poland). Acta Phys. Pol., 36: 269-71(Aug. 1969).

An argon plasma, with minute hydrogen impurities, of a temperature of 10,300°K was produced in a wall-stabilized arc. It was assumed that plasma formed thus was optically thin, quasi-neutral, and in local thermodynamic equilibrium. The transition probabilities of nineteen Ar I lines were calculated from the measured intensities of the emitted spectral lines and half-width of the H_β line. The results obtained agree well with those cited in the literature. (auth)

1393 RECOMBINATION OF ELECTRONS AND IONS IN AN ATMOSPHERIC ARGON PLASMA. Desai, S. W.; Corcoran, W. H. (California Inst. of Tech., Pasadena). J. Quant. Spectrosc. Radiative Transfer, 9: 1371-86(Oct. 1969).

Spectroscopic studies were made of a plasma jet of argon at atmospheric pressure. Analysis of temperatures, velocities, and excitation populations allowed the determination of the recombination coefficient for electrons and ions and prediction of a dissociative-molecular-ion model to describe the mechanism of the recombination. Temperatures were in the region from 3,000 to 11,000°K and electron densities in the range from 10^{12} to 10^{15}/cm^3. (auth) (UK)

1394 ULTRAVIOLET ABSORPTION IN CESIUM-SEEDED HYDROGEN. Freyheit, P. J. (Sperry Rand Research Center, Sudbury, Mass.); Norcross, D. W.; Stone, P. M. Contract No. NAS 1286. J. Quant. Spectrosc. Radiative Transfer, 9: 1387-1406(Oct. 1969).

The influence of cesium-seed fraction on the ultraviolet photoabsorption coefficient of a cesium–hydrogen plasma is determined over the pressure range from 0.1 to 100 atm. Plasma temperatures from 5000 to 20,000°K, and cesium/hydrogen ratios of 10^{-1}, 10^{-2}, 10^{-3} and zero are investigated, maintaining a constant electron density. The plasma photoabsorption coefficient is calculated in the ultraviolet region 4.0 to 25.0 eV. The most pronounced effect is due to the bound–free absorption of cesium at energies below the hydrogen ionization energy. This effect is important at low plasma temperatures. (auth) (UK)

1395 EXPERIMENTAL STUDY OF SATELLITE LINES OF A FORBIDDEN TRANSITION IN A LASER-PRODUCED HELIUM PLASMA. Baravian, G.; Benattar, R.; Bretagne, J.; Godart, J. L.; Sultan, G. (CNRS, Orsay, France). Phys. Lett., 30A: 198-9(Oct. 6, 1969). (In French).

The spectroscopic evolution of a helium plasma produced by a laser was studied. The 2^3P-4^3F line exhibits two satellites assumed to result from longitudinal plasma oscillations. (auth)

1396 INTERACTION PHENOMENA OF COLD MERCURY VAPOR PLASMAS. Bito, J. F. (Industrial Research Inst. for Electronics, Budapest). Acta Tech. Acad. Sci. Hung., 65: 125-38(June 30, 1969).

As a result of studies in the positive column of the low-pressure mercury vapor discharges of spaces far from the electrodes (no electrode perturbations) in case of symmetric cylinders, correlations were established between the excited mercury atom density of the inert gas discharges and the density of the metastable atoms. Relations governing the production and annihilation of ions, the energy losses of the electrons, the axial field strength, and the average electron density were derived. The theoretical treatment described is suitable for analysis of the interaction phenomena and for calculation of mean electron density in a convenient manner. (JPRS)

1397 CORRELATED MICROWAVE RADIATION FROM A BEAM-GENERATED TURBULENT MAGNETOPLASMA. Bradford, P. V.; Marshall, T. C.; Schlesinger, S. P. (Columbia Univ., New York). pp 117-29 of Turbulence of Fluids and Plasmas. Fox. Jerome (ed.). Brooklyn, Polytechnic Press of the Polytechnic Inst. of Brooklyn, 1969.

From Symposium on Turbulence of Fluids and Plasmas, New York. See CONF-680431.

Correlation in microwave radiation emitted from isolated, axially separated, regions of an electron-beam-generated turbulent magnetoplasma column was measured. The measurements indicate that enhanced radiation near the electron cyclotron harmonic frequencies is correlated with collective scale lengths compared to the wavelength of the radiation. The total power and correlation spectra were simultaneously measured in the vicinity of the electron cyclotron harmonics under different conditions of gas pressure, axial separation between sensing waveguides, and beam acceleration voltage. The strong correlated radiation in the vicinity of the second cyclotron harmonic revealed dispersion properties and correlation phase variations with magnetic field that suggest the radiation results from the interaction of slow electrostatic cyclotron harmonic waves with a critical number density surface. Correlation in the radiation was measured by determining the fringe visibility of the interference pattern in a manner analogous to the measurement of partial coherence. The experimental techniques employed show that correlation radiometry can be a valuable diagnostic aid in determining the extent and scale of collective instabilities in turbulent plasma. (auth)

1398 HIGH-FREQUENCY OSCILLATIONS IN BEAM–PLASMA INTERACTIONS. Shcheglov, O. S.; Zvereva, F. G. (Kuibyshev Pedagogical Inst., USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 23-6(July 1969).

Translated from Zh. Tekh. Fiz., 39: 37-41(Jan. 1969).

The intensity distribution of high-frequency oscillations in a low-pressure discharge was investigated for various values of the anode–cathode distance. The plasma is produced and controlled by an electron beam. It is found that the nature of the oscillations depends on the anode position. (auth)

1399 SELF-SUSTAINING DISCHARGE IN A MOVING GAS. Nesterov, V. A.; Rubashov, I. B.; Chaplii, V. I. Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 216-18(Aug. 1969).

Translated from Zh. Tekh. Fiz., 39: 302-5(Feb. 1969).

The effect of the flow velocity of a neutral gas on the value of the electric field (E_b) required for the onset of a self-sustaining discharge was investigated. By introducing the concept of effective field strength, one can reduce the case of a moving gas to that of a gas at rest, which can then be calculated using Townsend's theory. The dependence of E_b on the Mach number M and on the direction of the gas velocity has been determined experimentally. It has been shown both theoretically and experimentally that when the flow velocity is parallel to the field the value of E_b increases exponentially with increasing M. (auth)

1400 PLASMA FLOW FROM A HOT-CATHODE PENNING DISCHARGE INTO A VACUUM REGION WITH NO MAGNETIC FIELD. Gabovich, M. D.; Romanyuk, L. I.; Ustalov, V. V. (Inst. of Physics, Kiev). Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 207-12(Aug. 1969).

Translated from Zh. Tekh. Fiz., 39: 291-7(Feb. 1969).

The effect of the parameters of a hot-cathode Penning discharge on the diffusion of a plasma flowing from the discharge and entering a vacuum region with no magnetic field was investigated. It is shown that it is possible to control the topography of the plasma stream by varying the discharge voltage, the gas pressure in the discharge, and the magnetic field; even in the absence of a magnetic field parallel to the plasma stream, the axial component of the plasma flux accounts for a large fraction of the total momentum. (auth)

1401 INVESTIGATION OF THE MICROWAVE OSCILLATIONS EXCITED IN A GAS DISCHARGE BY AN ELECTRON BEAM. Sakharov, I. E. (Leningrad Polytechnic Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 198-206(Aug. 1969).

Translated from Zh. Tekh. Fiz., 39: 278-90(Feb. 1969).

The spatial distribution of the amplitude of microwaves generated in a gas discharge traversed by an electron beam and in the space surrounding the plasma itself was investigated with microwave antenna probes at different positions inside the experimental arrangement and at receiving horns located outside the apparatus. The power of the oscillations generated in the plasma column is compared with that of the wave radiated by the beam–plasma system as a function of the electron density, magnetic field, beam energy, and beam current. (auth)

1402 CONTRACTION OF A POSITIVE COLUMN. I. Baranov, V. Yu.; Ul'yanov, K. N. (All-Union Inst. of Electrical Engineering, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 176-82(Aug. 1969).

Translated from Zh. Tekh. Fiz., 39: 249-58(Feb. 1969).

The contraction mechanism of a positive column is studied. Experiments are performed on argon and argon with cesium. It is shown that the column can exist in a diffuse or contracted state, depending on the type of gas, pressure, and tube dimensions. Both these states are studied experimentally. It is shown that current contraction at intermediate and high pressures is thermal in nature. (auth)

1403 RADIATION FROM A DENSE PLASMA GENERATED BY AN EXPLODED WIRE IN VACUUM. Chekalin, E. K.; Shumanov, V. S. (Moscow Power Engineering Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 46-8(July 1969).

Translated from Zh. Tekh. Fiz., 39: 71-4(Jan. 1969).

Optical and spectral properties of an expanding dense plasma generated by exploded copper and aluminum wires 0.2 to 1.0 mm in diameter and 100 mm in length in vacuum were investigated. A capacitor bank with a total capacity of 41 μF, charged to 30 kV, was used. High-speed camera data (framing and streak modes), time scans of the plasma emission spectrum in the visual region, and the discharge characteristics (current and voltage) are presented. The processes were recorded in time synchronization. Analysis of the results show that the plasma expands as a cylindrical shell with pronounced instabilities on the leading edge of the plasma emission front. At the initial time a bright continuum flash (lasting 0.1 to 2.5 μsec depending on the wire material and wire diameter) is observed. An absorption spectrum indicative of nonuniform temperature in the plasma is detected at later stages of the expansion. The nature of the continuous spectrum in the initial stage of the explosion is discussed. (auth)

1404 ION SAMPLING THROUGH THE ANODE AND CATHODE OF A DC DISCHARGE. Held, Herman; Gilkinson, J. L.;

Chanin, L. M. (Univ. of Minnesota, Minneapolis). J. Appl. Phys., 40: 4395-9(Oct. 1969).

Measurements are reported of positive ions sampled through the anode and the cathode of a dc discharge in argon containing small concentrations of cesium. Data were obtained for argon pressures up to 3 torr and cesium pressures as high as 4×10^{-3} torr. Ions observed through the cathode were Ar^+, Ar^{++}, Ar_2^+, and Cs^+, through the anode Ar^+, Ar_2^+, and Cs^+ were measured. Comparison is made of anode and cathode sampling measurements. (auth)

1405 INFLUENCE OF RELAXATION EFFECTS IN NONEQUILIBRIUM J X B DEVICES. Argyropoulos, G. S.; Demetriades, S. T. (STD Research Corp., Pasadena, Calif.). J. Appl. Phys., 40: 4400-9(Oct. 1969).

The coupled distributions of current density, electron temperature, and plasma composition in nonequilibrium plasma flows depend strongly on relaxation effects arising from finite reaction rates and from electron-energy convection. This dependence is studied in multielectrode magnetohydrodynamic channels in conjunction with the influence of thermal and concentration diffusion, and of thermal and velocity boundary layers. Relaxation effects are shown to control the possibility of current shorting along the conductor walls and to influence the stability of the distributions. For slow reaction rates and large gas velocities, the current and plasma-property distributions tend to become uniform in the core of the flow, but in the electrode-boundary regions nonuniformities persist both in the transverse and in the flow direction, and are strongly dependent upon the gas temperature and velocity boundary layers. Consequently, although relaxation effects allow high conductivity layers to extend over the insulator segments of the electrode walls, the possibility of Hall potential shorting through this path depends critically on the length of insulator segment between electrodes. Converging solutions, describing stable operation, have been obtained for values of the local Hall parameter β/ϵ as high as 6, depending on the geometry. At high values of β/ϵ, the current density and plasma-property distributions become time-dependent, resulting in overall electrical characteristics that oscillate by large factors. (auth)

Kinetics (Theoretical)

Refer also to abstract 1492.

1406 (SU-IPR-327) HIGH-FREQUENCY BEAM-PLASMA INTERACTION AT FINITE TEMPERATURES. Seidl, M. (Stanford Univ., Calif. Inst. for Plasma Research). June 1969. Contracts AT(04-3)-326; NASA-NGR-05-020-077. 49p. Dep. CFSTI.

The dispersion equation corresponding to the interaction of an electron beam with a Maxwellian plasma was solved in quasi-static and infinite-geometry approximations. Two representative beams are considered: a parallel beam with isotropic velocity spread and a helical beam with different longitudinal and transverse temperatures. The aim of the work is to present an "Experimenter's Guide" to predict the frequency, growth rate, and wave numbers of the most unstable waves as functions of the basic beam and plasma parameters. The results of the calculations are presented in graphs suitable for comparison with the experiments. The effect of plasma and beam temperatures on the spectrum of the instabilities is discussed in detail. It is shown that the plasma temperature reduces the growth rate of the instabilities at cyclotron harmonic frequencies while a velocity spread in the helical beam suppresses the instabilities everywhere, except in the vicinity of the cyclotron harmonics. (auth)

1407 POPULATION OF HIGHLY EXCITED LEVELS IN RAREFIED PLASMAS. Beigman, I. L.; Mikhailchi, E. D. (Lebedev Inst. of Physics, Moscow). J. Quant. Spectrosc. Radiative Transfer, 9: 1365-9(Oct. 1969). (In Russian).

Capture-cascade equations for high n permit the substitution of summation for integration. An integral equation is derived within the Kramers approximation for the probabilities of radiative transitions. A solution to this equation is then found by using the Laplace transformation. The expression for the Seaton matrix is next obtained and is found to be in good agreement with numerical calculations. The following direct processes influencing level population are considered: radiative capture, electron-impact excitation, and dielectronic recombination. (auth) (UK)

1408 EVOLUTION OF A PLASMA INTERACTING WITH RADIATION. Kroell, W. (Univ. of Bochum, Ger.). J. Quant. Spectrosc. Radiative Transfer, 9: 1331-41(Oct. 1969).

One of the basic problems in the theory of irreversible thermodynamics is the formulation of general evolution criteria. A universal criterion of this kind for macroscopic systems with time-independent boundary conditions was derived by Glansdorff and Prigogine. This derivation refers to transport processes in matter like diffusion, heat conduction and chemical reactions. Radiative transfer was not included. In the investigation, described statistical mechanics are used to extend the evolution criterion and the principle of minimum entropy production to partially ionized, collision-dominated plasmas interacting with radiation. A plasma with collisional and radiative excitation and ionization phenomena not restricted to local equilibrium is considered. The entropy production, which is defined as the entropy change per unit time due to emission, absorption and scattering of radiation, is formulated with the use of statistical analogues to the fluxes and forces of irreversible thermodynamics. The time change of the entropy production is investigated for a homogeneous plasma and an isotropic radiation field. (auth) (UK)

1409 QUANTUM THEORY OF STATIC SHIELDING OF AN IMPURITY CHARGE BY AN ELECTRON GAS PLASMA IN A MAGNETIC FIELD. Horing, Norman J. (Stevens Inst. of Tech., Hoboken, N. J. Naval Research Lab., Washington, D. C.). Ann. Phys. (N. Y.), 54: 405-29(Oct. 1, 1969).

The detailed calculations of magnetic field effects on the static shielding of a point Coulomb impurity charge by a quantum plasma are presented. The quantum plasma is described in terms of the random phase approximation (RPA) inverse dielectric function (I) in a manner that is valid for arbitrary magnetic field strength (to take account of Landau quantization) and arbitrary temperature (statistical regime). Magnetic field effects are found to occur only in conjunction with quantum modifications of the static shielding law, and they are accompanied by spatial anisotropy. This is manifest in both low- and high-wavenumber shielding phenomena. (TSS) (auth)

1410 FLUCTUATIONS OF ELECTRIC POTENTIAL OUTSIDE THE CYLINDER OF RAREFIED MAGNETIZED PLASMA. Arsenin, V. V.; Selidovkin, A. D. Izv. Vyssh. Ucheb. Zaved., Radiofiz., 12: 1141-6(1969). (In Russian).

A simple expression is derived for the mean square value of fluctuations of the electric potential at frequencies close to the cyclotron frequency of ions outside the cylinder of rarefied magnetized plasma with nonequilibrium ion distribution. In this case, the plasma boundary is assumed to be sharp and the radius of the cylinder much greater than the mean Larmor radius of ions and much less than the distance from the axis to the observation point. The expression found may be used for estimating the intensity of thermal noises outside the plasma. (auth)

1411 EQUILIBRIUM OF A ROTATING ELLIPSOID IN EXTERNAL HF FIELDS IN THE PRESENCE OF A CONSTANT MAGNETIC FIELD. Lysenko, O. E.; Khizhnyak, N. A. Izv. Vyssh. Ucheb. Zaved., Radiofiz., 12: 1132-40(1969). (In Russian).

The problem on the equilibrium of an ellipsoidal plasmoid in the external hf fields in the presence of a constant magnetic field is considered. It is shown that in order to provide the equilibrium, the plasmoid must rotate with the frequency ω_0 about the axis of symmetry. The rotation frequency and the effective potential energy of plasmoid that ensures the equilibrium are calculated as a function of the plasmoid parameters and the value of the external magnetic field. (auth)

1412 A STUDY OF THE MINKOWSKI AND THE EH FORMULATIONS BY ANALYSIS OF RADIATION IN A MOVING PLASMA. Koyama, Masaki; Itakura, Kiyoyasu (Osaka Univ.). Electron. Commun. Jap. (Engl. Transl.), 50: 11-18(Dec. 1967).

The electromagnetic radiation or Cherenkov radiation of a moving charge in a moving plasma is treated to clarify the differences between the Minkowski formulation and the EH formulation by Chu. Hitherto, these two formulations have been considered to be equally applicable to problems involving moving media. However, it is found here that the Poynting vectors obtained by these formulations are different and that the Poynting vector obtained by the EH formulation is in the direction of movement of a charge in a small fractional frequency band, and thus the radiation condition is not satisfied. On the other hand, the Poynting vector obtained by the Minkowski formulation is found to satisfy the radiation condition and thus leads to physically reasonable results. An explanation is offered for the contradiction between the Minkowski and EH formulations. First, the fundamental equations of the Minkowski formulation are invariant for the Lorentz transformation. This indicates that the field vectors (E, B, H, D) are independent of movement of the medium and therefore the vectors M and P by which the vectors B and D are expressed are strictly field vector components and can not be considered as wave sources such as a current J. On the other hand, in the EH formulation the same physical meaning with a wave source such as a dipole moment is given to P and M. Therefore, in the Minkowski formulation, the concept applied in the stationary medium that P and M are

composed of dipole moments must be abandoned. Furthermore, it should be reconsidered that the EH formulation is not invariant for the relativistic transformation. (BBB)

1413 MAGNETOHYDRODYNAMIC TURBULENCE. Moreau, R. (Univ., Grenoble, France). pp 359-72 of Turbulence of Fluids and Plasmas. Fox, Jerome (ed.). Brooklyn, Polytechnic Press of the Polytechnic Inst. of Brooklyn, 1969.

From Symposium on Turbulence of Fluids and Plasmas, New York. See CONF-680431.

Turbulence in an incompressible, electrically conducting, fluid with a uniform applied magnetic field is considered. Three points are examined in detail: (1) ohmic dissipation, (2) distribution and transfer of energy, and (3) decay of MHD turbulence. Explicit laws are then obtained that describe the evolution of the turbulence characteristics, among which are those for the Taylor microscale λ and the Reynolds number of the turbulence. (TSS) (auth)

For abstracts of individual papers see: 1205, 1314, 1372, 1378, 1382, 1397, 1413, 1415–1423, and 1456–1458.

1414 PROCEEDINGS OF THE SYMPOSIUM ON TURBULENCE OF FLUIDS AND PLASMAS, NEW YORK, APRIL 16–18, 1969. Fox, Jerome (ed.). Microwave Research Institute Symposia Series. Volume XVIII. Brooklyn, Polytechnic Press of the Polytechnic Institute of Brooklyn, 1969. 538p. (CONF-680431).

Separate abstracts were prepared for the 19 papers considered in scope for NSA. (M.O.W.)

1415 INTRODUCTION TO BASIC PHENOMENA OF TURBULENCE IN PLASMA. Dupree, T. H. (Massachusetts Inst. of Tech., Cambridge). pp 3-12 of Turbulence of Fluids and Plasmas. Fox, Jerome (ed.). Brooklyn, Polytechnic Press of the Polytechnic Inst. of Brooklyn, 1969.

From Symposium on Turbulence of Fluids and Plasmas, New York. See CONF-680431.

The nature of plasma turbulence and its relation to fluid turbulence are discussed. The basic nonlinear processes and their possible roles in natural and laboratory plasmas are described. Special emphasis is given to transport, radiation, and acceleration mechanisms. The current status of the theory is evaluated. (auth)

1416 STOCHASTIC ACCELERATIONS BY STRONG ELECTRIC FIELDS. Orszag, Steven A. (Massachusetts Inst. of Tech., Cambridge). pp 17-28 of Turbulence of Fluids and Plasmas. Fox, Jerome (ed.). Brooklyn, Polytechnic Press of the Polytechnic Inst. of Brooklyn, 1969.

From Symposium on Turbulence of Fluids and Plasmas, New York. See CONF-680431.

A new formulation of the theory of plasma turbulence is given. In order to minimize technical details, the discussion is restricted to the problem of acceleration of particles in a prescribed stochastic electric field. A general many-species Vlasov plasma with self-consistent electric fields may be treated in a similar way. The theory includes several important new features that appear essential to the proper understanding of turbulent plasma, including spectral broadening of particle resonances (related to particle trapping) and the proper resolution of interactions as adiabatic or resonant. For the latter, it is found necessary to formulate the theory in a generalized Lagrangian coordinate system following clusters of particles in their phase-space orbits. (auth)

1417 PERIODIC PULLING AND THE TRANSITION TO TURBULENCE IN A SYSTEM WITH DISCRETE MODES. Lashinsky, Herbert (Univ. of Maryland, College Park). pp 29-46 of Turbulence of Fluids and Plasmas. Fox, Jerome (ed.). Brooklyn, Polytechnic Press of the Polytechnic Inst. of Brooklyn, 1969.

From Symposium on Turbulence of Fluids and Plasmas, New York. See CONF-680431.

Experiments with thermal-plasma devices (Q machines) frequently reveal the existence of spontaneous steady-state plasma oscillations with wavelengths comparable with the system dimensions and with discrete, harmonically related, frequencies that correspond to the different azimuthal mode numbers of the universal drift instability in the cylindrical plasma column. The discrete-mode spectrum is observed at low oscillation amplitudes; at higher amplitudes the discrete-mode spectrum gives rise to a continuous noise spectrum, characteristic of turbulence, that implies the introduction of new degrees of freedom. A mechanism is described and analyzed by which this transition to turbulence can occur in a system characterized by a modest number of discrete modes. This mechanism, called "periodic pulling," provides a means for modulation of the amplitude and frequency of the discrete modes, thus generating sidebands that eventually broaden the discrete mode frequencies until a continuous spectrum is produced. The analysis of periodic pulling is based on a model in which the modes are treated as an ensemble of van der Pol oscillations that are weakly coupled by the nonlinearity of the plasma medium. (M.O.W.)

1418 SPECTRUM AND DIFFUSION IN A TURBULENT PLASMA WITH COLLISIONAL AND COLLISIONLESS DISSIPATIONS. Tchen, C. M. (City Univ. of New York). pp 55-64 of Turbulence of Fluids and Plasmas. Fox, Jerome (ed.). Brooklyn, Polytechnic Press of the Polytechnic Inst. of Brooklyn, 1969.

From Symposium on Turbulence of Fluids and Plasmas, New York. See CONF-680431.

A spectral theory of plasma turbulence is proposed that is valid for collisional and collisionless plasmas, and from the turbulent spectrum, turbulent diffusion is derived. The Bohm diffusion is also derived. While the collisional dissipation is formulated by the molecular viscosity multiplied by a vorticity function, the mechanism of collisionless dissipation is founded instead on the Bohm diffusion. The spectral theory is based on the following cascade processes. The turbulent cascade in a collisionless plasma, which represents the transfer of energy across a turbulent spectrum, is not drained by a collisional dissipation only operative in a collisional plasma, but the drain is replaced by a crossing of energy from the turbulent spectrum over to the density spectrum, where a new cascade perpetuates, to be ultimately drained by a collisionless dissipation. A constant strong magnetic field is applied. The spectrum of turbulent fluctuations and the diffusion transverse to the magnetic field are considered. (auth)

1419 NONLINEAR ASPECTS OF THE BEAM–PLASMA INTERACTION. Davis, Jon A.; Bers, Abraham (Massachusetts Inst. of Tech., Cambridge). pp 87-108 of Turbulence of Fluids and Plasmas. Fox, Jerome (ed.). Brooklyn, Polytechnic Press of the Polytechnic Inst. of Brooklyn, 1969.

From Symposium on Turbulence of Fluids and Plasmas, New York. See CONF-680431.

The nonlinear and turbulent aspects of the beam–plasma interaction are dominated by overtaking and trapping processes in both beam and plasma. These phenomena invalidate the basic simplifying assumptions of presently available nonlinear theories such as quasi-linear and mode–mode coupling theory. In the absence of an adequate analytic, nonlinear theory, the beam–plasma interaction may best be studied through a computer simulation which can readily show the full nonlinear development of the interaction in time and space. A computer simulation of the one-dimensional homogeneous beam–plasma interaction is shown to reveal the nonlinear formation and characteristics of several important phenomena observed in laboratory experiments: (a) the scattering of the beam in velocity-space; (b) the formation in the plasma of a so-called "meniscus" and (c) the collisionless heating of the plasma by the beam. When plasma density gradients along the direction of beam flow are included, the magnitude of the generated electric field is greatly reduced. By modeling the beam with finite diameter disks and including plasma density gradients, one obtains qualitative agreement with the velocity distribution of the electron beam emerging from a laboratory beam–plasma experiment. It was found that plasma density gradients along the beam-flow direction are much more important in limiting the interaction intensity than are plasma temperature or collisions. (auth)

1420 NONLINEAR EFFECT IN BEAM–PLASMA TYPE INTERACTIONS. Hsuan, H. C. S.; Lonngren, K. E. (Univ. of Iowa, Iowa City). pp 109-16 of Turbulence of Fluids and Plasmas. Fox, Jerome (ed.). Brooklyn, Polytechnic Press of the Polytechnic Inst. of Brooklyn, 1969.

From Symposium on Turbulence of Fluids and Plasmas, New York. See CONF-680431.

Before the onset of complete turbulence in a plasma, various distinguishable nonlinear effects can be identified. In this work, one of these effects which occurs in a zeroth order solution in the investigation of beam-plasma type interactions was examined. The effect is the redistribution of particles under the influence of an inhomogeneous oscillating electric field. The interaction of a monochromatic longitudinal wave with a charged-particle beam in a nonlinear plasma is considered. (auth)

1421 THERMODYNAMIC LIMITS ON THE GROWTH OF TURBULENCE IN A HOMOGENOUS PLASMA. Chen, Robert L. W. (Emory Univ., Atlanta). pp 281-8 of Turbulence of Fluids and Plasmas. Fox, Jerome (ed.). Brooklyn, Polytechnic Press of the Polytechnic Inst. of Brooklyn, 1969.

From Symposium on Turbulence of Fluids and Plasmas, New York. See CONF-680431.

A bound on the nonlinear fluctuations in density and in electromagnetic field is obtained in terms of thermodynamic variables characterizing the initial state of a homogeneous plasma. (auth)

1422 ANALYTIC FORMS FOR DECAYING SPACE-TIME TURBULENCE FUNCTIONS. Shkarofsky, I. P. (Radio Corp. of America Victor Research Labs., Montreal). pp 289-301 of Turbulence of Fluids and Plasmas. Fox. Jerome (ed.). Brooklyn, Polytechnic Press of the Polytechnic Inst. of Brooklyn, 1969.

From Symposium on Turbulence of Fluids and Plasmas, New York. See CONF-680431.

The wave-number frequency-dependent spectral function, $S(k,\omega)$ and the space-time correlation function, $C(r,t)$, are considered in a turbulent flowing plasma. The function $S(k,\omega)$ is decomposed into $S(k)$ and $\Psi(k,\omega)$; where $\Psi(k,\omega)$ is the ratio of $S(k,\omega)$ to its frequency integrated value, and time-invariant scale lengths in $S(k)$ are assumed. Also, the Fourier transforms of $\Psi(k,\omega)$ are deduced, namely, the probability function $\Psi(r,t)$ and the regression function $\Psi(k,t)$. The Fourier transforms of $\Psi(k,\omega)$ gives $\Psi(r,t)$, which then has to be convolved with the space autocorrelation function $C(r)$. Computer calculations of the convolution integrals for complex $C(r)$, can yield the space-time correlation function, $C(r,t)$, necessary for probe cross-correlation measurements. As an illustration, simple expressions were obtained for $C(r)$ in order to illustrate resultant $C(r,t)$ forms. The applicability of Taylor's hypothesis was also tested. One can readily manipulate the $C(r,t)$ expressions even in the limit of $r = 0$ or $t = 0$, and find for $t = 0$ that Taylor's hypothesis does not require the assumption that the flow is frozen. Rather, the assumptions are that the root mean square Lagrangian displacement in a given time, associated with the decay, be much smaller than both the flow distance and the characteristic size of blobs having maximum energy. A first-order correction to Taylor's hypothesis is deduced, giving an effective velocity slightly greater than the mean convection velocity. This correction can, however, be time-dependent, which perhaps explains the variable convection velocity observed in frequency-filtered correlation measurements. (auth)

1423 THEORY OF PLASMA TURBULENCE AS APPLIED TO EXPERIMENTAL PHENOMENA. Drummond, W. E. (Univ. of Texas, Austin). pp 303-9 of Turbulence of Fluids and Plasmas. Fox. Jerome (ed.). Brooklyn, Polytechnic Press of the Polytechnic Inst. of Brooklyn, 1969.

From Symposium on Turbulence of Fluids and Plasmas, New York. See CONF-680431.

Whereas the theory of weak turbulence has been rather fully developed over the past few years, one is faced with the fact that, experimentally, the simplest plasma experiments often lead to strong turbulence. The two-stream instability is given as an example, and the development of the breakdown of weak turbulence is traced, together with an outline of the development of strong turbulence in this case. An interesting feature of this development is that, when the amplitude of the waves is sufficiently large, the weak turbulence theory is again valid. (auth)

1424 PLASMA PHYSICS: GENERAL SURVEY. Rosenbluth, M. N. (Inst. for Advanced Study, Princeton, N. J.). pp 205-20 of Contemporary Physics: Trieste Symposium 1968. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.1); CONF-680629(Vol.1).

A high-temperature, relatively dilute, gaseous plasma is considered. First, general topics are briefly discussed: the equations of motion (Vlasov's, Fokker-Planck's MHD), the problem of small-amplitude oscillations in an infinite, homogeneous plasma, the Landau damping, and the motion of a charged particle in a given magnetic field. Attention then is concentrated on the problem of the stable confinement of a plasma by means of a magnetic field. Open and closed geometries are both examined and their MHD instabilities discussed, showing how they can be eliminated. Then the problem of microinstabilities is studied. A general discussion starting with quasi-thermodynamic considerations serves to individuate the most dangerous microinstabilities present in the open and closed geometries. These are briefly discussed. (auth)

1425 ELECTRON RECOMBINATION COEFFICIENT WITH THREE-BODY COLLISIONS IN A PLASMA. Veselovskii, I. S. Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 193-7(Aug. 1969).

Translated from Zh. Tekh. Fiz., 39: 271-7(Feb. 1969).

The electron-ion recombination coefficient due to three-body collisions of the type $A^+ + 2e \rightarrow A + e$ is calculated. The Fokker-Planck equation is developed for electrons with finite energy in the case of a dense, low-temperature plasma. The Landau kinetic equation is averaged over the fast component. A solution to the Fokker-Planck equation corresponding to a steady-state flux in energy space is found. (auth)

1426 CHAIN MECHANISM FOR THE DEVELOPMENT OF AN ARC DISCHARGE IN CROSSED ELECTRIC AND MAGNETIC FIELDS. Kononenko, Yu. G.; Savchenko, O. Ya.; Shun'ko, E. V. Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 191-2(Aug. 1969).

Translated from Zh. Tekh. Fiz., 39: 269-70(Feb. 1969).

It is assumed that the characteristics of the discharge are explained by direct ionization of neutral particles by ions. The sharp increase of the current with a slight change in the voltage is explained, within the framework of this assumption, by the development of chain reactions of the type $A^+ + A \rightarrow 2A^+ + e$ (for a monatomic gas), or $A^+ + A_2 \rightarrow 2A^+ + A + e$ (for a diatomic gas), which assure in practice any given number of current carriers, that is, A^+ ions. (M.O.W.)

1427 CONTRACTION OF A POSITIVE COLUMN. II. Baranov, V. Yu.; Ul'yanov, K. N. (All-Union Inst. of Electrical Engineering, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 183-90(Aug. 1969).

Translated from Zh. Tekh. Fiz., 39: 259-68(Feb. 1969).

A theory is developed for a nonisothermal arc in a local-collision mode. The distribution of electron density in space is determined by the temperature distributions and radiation field. In a weakly ionized plasma in which scattering by ions can be ignored the effective radius of the arc decreases with a decrease in current and the field strength passes through a maximum. The Coulomb collisions cause an increase in the effective current radius. The conclusions of the theory are confirmed by the experimental results given in the first part of the study. (auth)

1428 AMPLIFICATION OF ELECTRIC-FIELD FLUCTUATIONS CLOSE TO A BODY IN PLASMA. Smirnova, V. V. Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 32-40(July 1969).

Translated from Zh. Tekh. Fiz., 39: 49-63(Jan. 1969).

An investigation is made of the amplification of the electric-field fluctuations near a body in a plasma when the surface of the body is maintained at a high positive potential. The structure of the disturbed region near the body is determined, i.e., the directed velocity, the effective temperature, and the density of particles are calculated as functions of the distance from the body surface. The region of instability with respect to longitudinal waves is studied and the amplification of monochromatic signals in this region is investigated under the assumption that the linear approximation can be used. The fluctuation growth due to the presence of a charged-particle current is found. Fluctuation amplification in the disturbed region is calculated for the case in which the instability range is approached and for the case in which the state passes through instability range. (auth)

1429 ANGULAR DISTRIBUTION OF ELECTRONS ESCAPING AT A PLASMA-ELECTRODE INTERFACE. Stakhanov, I. P.; Shcherbinin, P. P. Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 219-26(Aug. 1969).

Translated from Zh. Tekh. Fiz., 39: 306-16(Feb. 1969).

A method is proposed for the solution of the Boltzmann equation with isotropic scattering and a boundary condition which describes mirror reflection of particles. The problem is reduced to a singular integral equation which is then transformed into a Fredholm equation of the second kind. The solution of this equation yields a particle angular distribution function which is almost linear. In the limiting case of no reflecting barrier the Fredholm equation degenerates into a solution of the Milne problem. The singular integral equation is solved by an approximation method in which it is reduced to a differential equation. (auth)

1430 INTERACTION OF A MODULATED CHARGED-PARTICLE BEAM WITH A PLASMA IN A MAGNETIC FIELD. I. EXCITATION OF CHARACTERISTIC PLASMA OSCILLATIONS BY MODULATED ELECTRON BEAMS. Pashitskii, E. A. (Inst. of Physics, Kiev). Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 149-54(Aug. 1969).

Translated from Zh. Tekh. Fiz., 39: 209-17(Feb. 1969).

In this work linear self-consistent characteristic oscillations of a magnetoplasma excited by a low-density modulated electron beam are investigated. It is shown that the modulated beam drives oscillations in the plasma. These are excited as a result of two-stream instabilities and exhibit a discrete spectrum with respect to the longitudinal wavelength corresponding to space parametric resonances between the beam and the plasma. The ratio of the "wavelength" of the modulation (i.e., the length of the electron bunches) to the radius of the beam determines the excitation of the oscillations as a result either of the anomalous Doppler effect (narrow beam) or Cherenkov effect (wide beam). It is shown that the thermal spread of electron longitudinal velocities reduces the growth rate of the oscillations in the plasma. The presence of uncompensated variable space charge in the beam has no effect on the excitation of the oscillations with the maximum growth rate. (auth)

1431 INTERACTION OF A MODULATED CHARGED-PARTICLE BEAM WITH A PLASMA IN A MAGNETIC FIELD.

II. EXCITATION OF CHARACTERISTIC PLASMA OSCILLATIONS BY MODULATED ION BEAMS. Pashitskii, E. A. (Inst. of Physics, Kiev). Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 155-62(Aug. 1969).

Translated from Zh. Tekh. Fiz., 39: 218-29(Feb. 1969).

The excitation of various oscillations in a magnetoplasma by a low-density modulated ion beam is investigated in the self-consistent approximation. It is shown that for longitudinal injection of the beam into the plasma the excitation of oscillations is due primarily to the anomalous Doppler effect because the length of the ion bunches is considerably greater than the radius of the beam. The finite thermal spread of the beam ions with respect to longitudinal velocities leads to a reduction in the growth rate of the oscillations. For injection of the ion beam at an angle to the magnetic field the excitation mechanism depends strongly on the modulation frequency of the beam: for modulation frequencies much less than the cyclotron frequency of the beam ions, oscillations are excited by the Doppler effect. For higher modulation frequencies, in which the length of the ion bunches is less than the gyro radius of the beam ions, the excitation is due to the Cherenkov effect. (auth)

1432 ENERGY LOSS OF FAST TEST IONS IN A PLASMA WITH A STRONG MAGNETIC FIELD. May, R. M.; Cramer, N. F. (Univ. of Sydney). Phys. Lett., 30A: 141-2(Oct. 6, 1969).

Numerical results are presented for the effect of a strong magnetic field on the rate of energy loss by a fast test ion in a plasma ("strong" field means the electron cyclotron frequency is greater than the plasma frequency). (auth)

1433 LOCAL THERMODYNAMIC EQUILIBRIUM CONDITIONS IN SUPERHIGH-PRESSURE HELIUM PLASMAS PRODUCED BY LASER ACTION. Rachman, A.; Bassani, L. (Laboratoire de Physique, Poitiers, France). Phys. Rev. Lett., 23: 954-7(Oct. 27, 1969).

An analysis is presented of gas breakdown by laser action, assuming that the final state of the laser-beam–gas interaction is described by a plasma in local thermodynamic equilibrium. A simple formula is obtained which correlates the threshold electric field with the initial gas pressure and the temperature, in agreement with experiments. (auth)

1434 EFFECT OF LARGE ELECTRIC FIELDS ON THE ELECTRON ENERGY DISTRIBUTION AND IONIZATION RATE IN A CESIUM DISCHARGE. Shaw, D. T.; Margolis, S. G. (State Univ. of New York, Buffalo). J. Appl. Phys., 40: 4377-83(Oct. 1969).

The Boltzmann equation with the electric field and the collision terms is solved numerically for a spatially uniform, steady-state, cesium thermionic plasma. The collision terms include the elastic, inelastic, and electron–electron Coulomb interactions. The Fokker–Planck approximation of the Coulomb collision is used in the present study. The effects of non-Saha population on the electron energy distribution and ionization rate near the emitter are discussed. (auth)

1435 ELECTRICAL CONDUCTIVITY OF A GAS IONIZED BY AN EXTERNAL SOURCE. Vol'f, E. M.; Polikanov, V. S. Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 105-8(July 1969).

Translated from Zh. Tekh. Fiz., 39: 152-8(Jan. 1969).

The effect of finite electron attachment time on the electrical conductivity of an ionized gas is investigated for arbitrary electric field geometry. It is shown that this factor cannot be neglected for high radiation intensities. Asymptotic equations are obtained for the ion current as $U \to 0$ and $U \to \infty$, where U is the potential difference between the electrodes; an interpolation equation which is approximately correct for all U is derived. It is shown that the scaling law formulated earlier remains valid in this case. (auth)

1436 EFFECT OF SPACE CHARGE AND DIFFUSION ON THE ELECTRIC CONDUCTIVITY OF A GAS IONIZED BY AN EXTERNAL SOURCE. Vol'f, E. M.; Polikanov, V. S. Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 99-104(July 1969).

Translated from Zh. Tekh. Fiz., 39: 143-51(Jan. 1969).

It is shown that the equation for the ion current obtained earlier (neglecting the effect of space charge and assuming an external source of ionization) is valid when space charge is taken into account if the arithmetic mean of the mobilities of the positive and negative ions is nearly the same as the geometric mean. An approximate equation is derived for the case in which this condition is not satisfied. It is shown that the similitude laws obtained earlier are satisfied when space charge is taken into account. The equation relating the maximum and minimum values of the electric field in the conducting gap is generalized from the plane case to arbitrary geometry. A method is proposed for measuring mutual capacitances of complex systems of electrodes by using an ionization radiation source. (auth)

1437 PLASMA STREAM IN AN INHOMOGENEOUS TRANSVERSE MAGNETIC FIELD. Demidenko, I. I.; Lomino, N. S.; Padalka, V. G.; Rutkevich, B. N.; Sinel'nikov, K. D. Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 16-22(July 1969).

Translated from Zh. Tekh. Fiz., 39: 27-36(Jan. 1969).

A study is made of the motion of a dense plasma stream across an inhomogeneous magnetic field. The motion is shown to be adiabatic, and the magnetic moment produced when the plasma enters the magnetic field is determined. The transverse and longitudinal stream polarizations and the variation in the thickness of the stream during its motion in the nonuniform magnetic field are investigated. The experimental results are in excellent agreement with theoretical calculations based on the drift approximation. (auth)

1438 TRANSITION BETWEEN THE QUASI-STATIC AND IMPACT LIMITS IN SPECTRAL LINE BROADENING. Bezzerides, Bandel (Stanford Univ., Calif.). Phys. Rev., 186: 239-44(Oct. 5, 1969).

A kinetic description of line broadening is used to express the conventional approximation schemes as limits of a more general point of view. A profile function is given in terms of a generalized collision rate. Central to the calculation of this rate is a perturbed phase function that accounts for possible strong coupling between perturbers and the particle coupled to the light. An approximate expression for this phase function is given which continuously describes the transition between the two limits. (auth)

1439 THERMODYNAMIC PROPERTIES OF NONIDEAL GASES. I. FREE-ENERGY MINIMIZATION METHOD. Graboske, H. C. Jr.; Harwood, D. J.; Rogers, F. J. (Univ. of California, Livermore). Phys. Rev., 186: 210-25(Oct. 5, 1969).

The thermodynamic properties of nonideal or interacting gases are studied using a thermodynamically consistent method which derives a state function for the gas from a separable Hamiltonian for the many-body system. The state function—the Helmholtz free energy—is a sum of translational, configurational, and internal components, and the statistical equilibrium state is calculated on a computer by minimizing the free energy in composition space at a given volume and temperature. A series of free-energy models is constructed to investigate the effects of various interactions. The effects on the equilibrium state of including Fermi–Dirac statistics in the translational free energy are shown to be small, while Coulomb and excluded-volume configurational terms produce large thermodynamic effects. The most important interaction effect, the modification of the internal partition function, is studied using a free-atom model and a confined-atom model which introduce volume- and temperature-dependent energy eigenvalues and partition-function sum terminations. The free-energy minimization method is shown to be a versatile and efficient tool for studying interacting gases, and provides quantitative estimates of the limits of validity of the various interaction models. (auth)

1440 ASYMPTOTIC BEHAVIOR OF THE GENERALIZED WIDTH AND SHIFT FUNCTIONS IN THE ELECTRON-IMPACT BROADENING THEORY OF NEUTRAL SPECTRAL LINES IN PLASMAS. Deutsch, C. (Faculte des Sciences, Paris); Herman, L.; Drawin, H. W. Phys. Rev., 186: 204-9(Oct. 5, 1969).

Explicit asymptotic formulas are derived for the generalized functions $A(z_1,z_2)$ and $B(z_1,z_2)$, which define the matrix elements of the electron-collision operator, in the impact broadening theory of Griem, Baranger, Kolb, and Oertel, recently extended in order to take into account any degree of degeneracy of the overlapping lines in plasmas. The results are shown graphically and confirm a complementary behavior previously predicted. The shift function remains greater than the width function in the whole asymptotic domain. (auth)

Production

1441 FUNNEL-TYPE PLASMA SOURCE. Takamura, Syuichi; Tanaka, Yuji (Nagoya Univ., Japan). Kakuyugo Kenkyu, 23: No. 4, 192-205(Aug. 1969). (In Japanese).

The plasma source explored in this experiment is of the back-diffusion type. The working gas is argon and helium. The pressure is as low as $10^{-4} \sim 10^{-3}$ torr. The electron density is $10^{5} \sim 10^{8}$ cm^{-3}. The electron temperature can be changed from 0.4 to 1.4 eV. The electron drift velocity may also be controlled. Its increase leads to a decrease of the damping of the ion waves. The ion tem-

perature is estimated to be 0.27 ± 0.02 eV from the Landau damping of the ion wave. The ion beam with low energy is easily produced, and its energy can be controlled. (NSA of Japan)

Stability

Refer also to abstracts 1406, 1423, and 1424.

1442 NATURE OF HIGH-FREQUENCY INSTABILITY OF LOW-PRESSURE DISCHARGE IN MAGNETIC FIELD. Kozak, O. V.; Pasechnik, L. L.; Pashitskii, E. A. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 14: 231-4(Feb. 1969). (In Russian).

The interpretation of earlier experimental results on excitation of the oscillations with frequencies ~10 MHz in a low-pressure hot-cathode discharge in some critical magnetic fields H_{cr} is given on the basis of the high-frequency drift instability of plasma with a large electron temperature gradient. It is shown that this theory enables one to explain essential experimental facts (existence of H_{cr}, its value and dependence on gas pressure and plasma density, and observed frequency range). (auth)

1443 NONLINEAR PLASMA PHYSICS. Dupree, T. H. (Massachusetts Inst. of Tech., Cambridge). pp 221-35 of Contemporary Physics: Trieste Symposium 1968. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.1): CONF-680629(Vol.1).

The following topics are discussed: (1) nature of nonequilibrium effects; (2) linear theory; (3) nonlinear theory; (4) wave–wave coupling; (5) weak wave–particle interactions; (6) a single nonlinear wave; and (7) a few nonlinear waves. (M.O.W.)

1444 STABILIZATION OF CERTAIN PLASMA INSTABILITIES BY HIGH-FREQUENCY PRESSURE. Sidorov, V. P. (Physical-Technical Inst., Sukhumi, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 169-70(Aug. 1969).

Translated from Zh. Tekh. Fiz., 39: 238-40(Feb. 1969).

Using rather general assumptions a time-averaged rf force is found which acts on the electrons due to a field of the form $E_\parallel = E_0(x) \exp(-i\Omega t + ik_y^0 y)$. It is demonstrated that drift-connective and flute instabilities can be stabilized by high-frequency pressure. The amplitude of the rf field necessary for stabilization is given. (auth)

1445 LOW-FREQUENCY HYDRODYNAMIC INSTABILITY OF A CURRENT-CARRYING INHOMOGENEOUS PLASMA. Baikov, I. S.; Kogan, E. Ya.; Moiseev, S. S.; Rukhadze, A. A. (Novosibirsk State Univ., USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 163-8(Aug. 1969).

Translated from Zh. Tekh. Fiz., 39: 230-7(Feb. 1969).

The stability of an inhomogeneous dense plasma with longitudinal currents contained by strong magnetic fields is investigated. From the two-fluid magnetodynamic equations one obtains a dispersion relation which determines the spectra of small oscillations of the inhomogeneous plasma in the limit of geometric optics. It is shown that in an inhomogeneous dense plasma that is collision dominated even a small longitudinal current can lead to a low-frequency instability in the range $k_\parallel v_{Ti} > \omega_e$. This instability in a dense plasma is very difficult to stabilize by weak crossed magnetic field lines (shear); therefore, it is very dangerous from the point of view of magnetic plasma containment. (auth)

1446 REVERSIBILITY AND THE DAMPING OF A DOUBLE BEAM INSTABILITY. Motz, H.; Rumsby, P. T. (Oxford Univ.). Phys. Rev. Lett., 23: 964-6(Oct. 27, 1969).

An experimental and theoretical investigation has been made of the absolute instability that occurs near $\frac{1}{2}\omega_c$ when two opposing drifting electron beams interpenetrate in a static magnetic field. The theory allows determination of the beam temperature by measurement of cutoff magnetic field or cutoff beam velocity. The result of the measurement is that the beam temperature is equal to the cathode temperature and it is concluded that no irreversible change takes place. (auth)

1447 NONLINEAR GENERATION OF CYCLOTRON HARMONICS FROM A COHERENT PLASMA FLUTE MODE. Bodner, S. E.; Byers, J. A. (Univ. of California, Livermore). Phys. Rev. Lett., 23: 967-9(Oct. 27, 1969).

Stimulated by a computer simulation of a plasma flute mode, a theoretical argument was developed to show that a single-wavelength, unstable flute mode, $\omega \neq \omega_c$, will nonlinearly shift some of its energy to the nearest cyclotron harmonics. (auth)

1448 STABILITY OF A MAGNETIZED PLASMA IN A STRONG HIGH-FREQUENCY FIELD. Gorbunov, L. M.; Silin, V. P. (Lebedev Inst. of Physics, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 1-9(July 1969).

Translated from Zh. Tekh. Fiz., 39: 3-17(Jan. 1969).

The stability of a plasma in a strong high-frequency field and in a constant uniform magnetic field is considered. The case in which the high-frequency field is perpendicular to the magnetic field is studied in detail. It is shown that in this case, as well as in a plasma without a magnetic field, both aperiodic short-wave instabilities and oscillatory instabilities at a frequency near the electron plasma frequency are possible. In a strong magnetic field in which the cyclotron frequency is greater than the frequency of the high-frequency field, the growth rates are reduced as the magnetic field increases. (auth)

Thermonuclear Processes

1449 INTERACTION OF CAPACITOR-BANK-PRODUCED MEGAGAUSS MAGNETIC FIELD WITH SMALL SINGLE-TURN COIL. Shearer, J. W. (Univ. of California, Livermore). J. Appl. Phys., 40: 4490-7(Oct. 1969).

Experiments on the production of high magnetic fields in single-turn coils by means of high-voltage capacitor banks are described. Fields as high as 3.5 megagauss have been produced. Numerical analysis of the interaction of this field with the metal wall shows that magnetic diffusion and wall compression are the principal interaction phenomena. In addition, experimental and theoretical evidence are presented for the emission of a vapor cloud by the wall into the magnetic-field volume. Finally, a simple approximate method for calculating the early time history of the magnetic field and coil motion is shown to give reasonable agreement with experiment. (auth)

1450 ON-OFF LIQUID HELIUM CRYOPUMP (Apr. 16, 1968) (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE-1901).

17 drawings.

An on–off thermal switch for thermally isolating the LHe storage from the pumping surface is incorporated into a cryopump, which results in an increased pumping rate and efficiency as well as less-hazardous operating procedures. The switch is a hermetic volume between the LHe storage and the pumping surface. Gas is introduced into the insulating space to establish thermal contact between the LHe and the pumping surface; then the gas is evacuated to thermally isolate the pumping surface. (For details see TID-4100 Suppl. 54) (See also NSA 23: 23185) (auth)

1451 ASTRON 1.4 METER MAGNET (Apr. 17, 1967) (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE-1922).

22 drawings.

In the Astron 1.4 meter magnet system, one hundred twelve solenoids are required to provide 90 ft of lumped solenoids on 9.6-in. centers. Lumped solenoids are used to provide maximum diagnostic access. Conductor layers in multiples of two minimize axial current flow. Odd-numbered layers impart axial flow in one direction, which is cancelled by reverse flow in even-numbered layers. To further cancel net flow, adjacent modules wound in opposite sense impart divergent current flow in layers of equal radii. Field perturbations induced by the leads are minimized by a coaxial arrangement. The magnet modules are optimized for 30 kW power supplies. The outside walls of the vacuum tanks provide the required roundness for the magnet system, but Al alloy cores are used to maintain the proper roundness and accurate module spacing. The cores are supported on the tank by expandable rubber blocks. Water for cooling enters the system through fittings placed opposite the terminals. Parallel flow occurs in the top and bottom layers. Flow from the top layer directly enters the coaxial cavity, while water from the bottom layer discharges through a tube in the lower terminal. (For details see TID-4100 Suppl. 55). (See also NSA 23: 23184) (F.S.)

1452 CRYOGENIC SYSTEM FOR BASEBALL II MAGNET (Aug. 25, 1969) (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE-1918).

19 drawings.

The cryogenic system for the cooldown and operation of the superconducting Baseball magnet for Alice, includes a He liquifier capable of producing 60 liters/hr of liquid He; a liquid He storage Dewar vessel of 10,000 liter capacity to act as thermal ballast in the system, a 500-liter magnet Dewar with a Joule–Thompson valve; and a gas storage, recovery, and purification facility. The magnet can be cooled by operating the liquifier as a refrigerator or by a direct transfer of liquid He from the Dewar. The He liquefier, which operates on the Claude cycle employs liquid N_2 for precooling, a single expander, and a Joule–Thompson expansion valve. Cooling from room temperature to the steady-state operating temperature of 4.4°K takes ~25 hr under optimum conditions using the refrigerator. In the event of refrigerator failure or for

additional cooling, liquid He can be transferred from the 10,000-liter Dewar directly into the 500-litter magnet Dewar. (For details see TID-4100 Suppl. 55) (See also NSA 23: 23183) (F.S.)

1453 2X-VACUUM SYSTEM (June 24, 1969) (Engineering Materials). (California Univ., Livermore, Lawrence Radiation Lab.). (CAPE-1917).

8 drawings.

The vacuum chamber for the 2x machine, a twice-scale model of the Toy Top III machine, consists of two aluminum end tanks connected by a glass center section. The total volume of the chamber is 11,000 liters. Operating pressures of 2 to 3×10^{-9} and base pressures of 5 to 8×10^{-10} are obtained with a 100°C bake. Operation is on a two-min cycle with each cycle consisting of a one-min delay for cooldown followed by one min of gettering during which time the 4.16-mJ capacitor banks are charged. The field has a rise time of 150 to 200 μsec, at which time the banks are crobarred. (For details see TID-4100 Suppl. 55) (See also NSA 23: 23186). (F.S.)

Wave Phenomena

Refer also to abstracts 1398, 1443, and 1719.

1454 CHARGE MOTION IN A SOUND WAVE PROPAGATING IN A WEAKLY IONIZED PLASMA. Biragov, S. B. (Gorky State Univ., USSR). Izv. Vysah. Ucheb. Zaved., Radiofiz., 12: 1147-51(1969). (In Russian).

The motion of charged particles in a weakly ionized plasma due to oscillations of neutral particles in a sound wave is considered in a quasi-hydrodynamic approximation. The electric fields and currents occurring in this case are calculated. In isotropic plasma, the indicated effect is associated with different electron and ion drag by neutral particles. Conditions are obtained under which the greatest fields and currents occurred. (auth)

1455 DAMPING AND PHASE SHIFT OF MHD WAVES IN A PLASMA HAVING FINITE ELECTRICAL AND THERMAL CONDUCTIVITY. Simonics, Gy. (Industrial Research Inst. for Electronics, Budapest). Acta Phys. Acad. Sci. Hung., 26: 291-9 (1969).

Formulas describing the propagation of small-amplitude MHD waves in any direction relative to the external magnetic field in a plasma of infinite extension and of finite electrical and thermal conductivity were derived from the fundamental equations of magnetohydrodynamics. The waves generated in the medium are damped and phase differences appear between the perturbations of the MHD quantities. These properties of the waves can be described by a complex refractive index. (auth)

1456 LOW-FREQUENCY FLUCTUATIONS IN A WEAKLY TURBULENT HOLLOW-CATHODE DISCHARGE PLASMA. Chung, K. (Polytechnic Inst., Brooklyn); Rose, D. J. pp 311-32 of Turbulence of Fluids and Plasmas. Fox, Jerome (ed.). Brooklyn, Polytechnic Press of the Polytechnic Inst. of Brooklyn, 1969.

From Symposium on Turbulence of Fluids and Plasmas, New York. See CONF-680431.

The long hollow-cathode arc of M.I.T. demonstrated that it could produce remarkably quiescent argon plasma. The system employs a hot hollow cathode, a differential pumping scheme, and a long, uniform magnetic field. Typically, the plasma is a highly ionized (≥90% ionization), moderate-temperature ($T_i \leq 1$ eV, $T_e \leq 10$ eV) plasma with a density of 10^{12} to 10^{14} cm^{-3}. Although the plasma could be quiescent ($\Delta n/n < 1\%$) at optimal operating conditions, it usually exhibits plasma fluctuations of the density and the floating potential. The low-frequency plasma fluctuations were studied, using electrostatic probes. For a detailed analysis of the coherent part of the fluctuations, an electronic correlator was used. In this study, main attention was focused on the coherent fluctuations in order to attempt an interpretation of the fluctuations by the weak plasma turbulence theory. The variations of frequency and amplitude of the coherent oscillations with respect to plasma parameters are mapped out. In this plasma two kinds of coherent oscillations were found at two different operating conditions. One mode is found to be a drift-wave instability due to the density gradient at the plasma boundary. This mode is a pure m = 1 azimuthal mode and is localized at the boundary. The frequency of this mode is 8 to 20 kHz and it propagates in the $\vec{E}_0 \times \vec{B}_0$ direction. The other mode has a frequency of 50 to 80 kHz and harmonics are strong for this mode. This mode is interpreted as the electrostatic ion cyclotron waves generated in the source region and propagating through the long drift region. In this paper, the machine, the characteristics of the plasma, the experimental techniques and the properties of the coherent oscillations are described. The rationale for the identification of these modes is given. Also, it is pointed out that the steady-state density distribution indicates a disagreement with the classical diffusion process in the weakly turbulent plasma. (auth)

1457 ELECTROMAGNETIC SCATTERING FROM UNDERDENSE RANDOM PLASMA SLABS. Hochstim, A. R.; Martens, C. P. (Inst. for Defense Analyses, Arlington, Va.). pp 187-215 of Turbulence of Fluids and Plasmas. Fox, Jerome (ed.). Brooklyn, Polytechnic Press of the Polytechnic Inst. of Brooklyn, 1969.

From Symposium on Turbulence of Fluids and Plasmas, New York. See CONF-680431.

A numerical method for exactly calculating the mean reflection coefficient of a plasma slab having a randomly varying dielectric constant is developed. The method is applied to the case of a wave normally incident upon a slab which, when unperturbed is homogeneous. The assumed electron density fluctuation is of the form of a random telegraph signal. In addition to the customary technique which utilizes the power spectrum of the electron density fluctuation, the first-order Born approximation is also used to calculate the mean reflection coefficient by a statistical averaging method for the case of the random telegraph signal fluctuation. This method takes into account the finite thickness of the slab and utilizes the probability density of the lengths of the intervals in which the electron density fluctuation is constant. The results obtained from the computer model and from the first-order Born approximation are compared. For an underdense collisionless plasma and small electron density fluctuations, the agreement is satisfactory. For intermediate densities, the mean of the fluctuating component of the reflection coefficient is a linear function of the mean square electron density fluctuation, but with a different slope from that predicted by the first-order Born approximation. As the plasma becomes more dense, the slope for small-density fluctuations is often negative, and for larger fluctuations the relationship is nonlinear due to multiple scattering. (auth)

1458 MICROWAVE SCATTERING FROM TURBULENT PLASMA. Granatstein, V. L. (Bell Telephone Labs., Inc., Whippany, N. J.); Buchsbaum, S. J. pp 231-49 of Turbulence of Fluids and Plasmas. Fox, Jerome (ed.). Brooklyn, Polytechnic Press of the Polytechnic Inst. of Brooklyn, 1969.

From Symposium on Turbulence of Fluids and Plasmas, New York. See CONF-680431.

Microwaves (8 mm and 4 mm) are scattered from density fluctuations in a cylindrical weakly ionized turbulent plasma. The column is several wavelengths in diameter and the modulation of plasma is strong ($\tilde{n}_{rms}/\bar{n} \sim 1$). The scattering cross section was observed as a function of plasma density with the ratio $\tilde{n}_{rms}/\bar{n}$ held constant. For small plasma density, $\sigma \propto \tilde{n}^2_{rms}$ in agreement with single-scatter (Born) theory. There is a break from this relationship at $\tilde{n}^2_{rms}/(n^2_{cr} \sin \alpha) \sim 0.01$, apparently as a result of strong small-angle scattering (α is the angle between the incident microbeam and the column axis). After the break, σ increases more slowly and goes through a broad peak when a significant volume of the plasma becomes overdense. Within the range of validity of the Born approximation, $\sigma \propto S_1(K_z)$; $S_1(K_z)$ is the one-dimensional spectrum of the fluctuations along the gas flow axis and is measured with electrostatic probes. This indicates that the turbulence is strongly anisotropic with scale along the flow axis ($l_z \sim 6$ mm) much larger than the transverse scale. The scattered return for large $K_z l_z$ is significantly depolarized, indicating the presence of multiple scattering. (auth)

1459 OSCILLATIONS OF A WEAKLY IONIZED COLLISIONAL PLASMA. Markeev, B. M. (Inst. of Terrestrial Magnetism, Ionosphere, and Radiowave Propagation, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 307-9(Sept. 1969).

Translated from Zh. Tekh. Fiz., 39: 417-21(Mar. 1969).

The effect of collisions on the propagation of waves in a homogeneous plasma with weak ($\omega \gg \nu_{in}, \nu_{en}$) and strong ($\nu_{in} \ll \omega \ll \nu_{en}$) collisions is investigated in this study. The damping constants are computed. In contrast to studies in which a model collision integral (Bhatnagar–Gross–Krook) is used, here the dielectric tensor for the plasma with weak collisions is obtained on the basis of a kinetic equation with an exact Boltzmann collision integral. In the case of a plasma with strong collisions the dielectric tensor is computed by the method of variation of the equilibrium current. In obtaining the equilibrium electron current the kinetic equation with a Davydov collision integral is utilized. It is shown that in a plasma with strong collisions, when the longitudinal diffusion coefficient $\xi = (k_z v_{Te})^2/\omega\nu_{en} \gg 1$, there exists an ion–acoustic wave analogous to the ion–acoustic wave in a nonisothermal plasma with weak collisions. (auth)

1460 TRAPPED PARTICLES AND ECHOES. Wong, Alfred Y.; Taylor, Robert J. (Univ. of California, Los Angeles). Phys. Rev. Lett., 23: 958-61(Oct. 27, 1969).

The investigation of trapped particles in a negative electrostatic well by small perturbing pulses (separation τ) reveals long trapping time and anharmonic orbits. New echoes occurring at fractions of τ are observed whose frequencies are harmonics of the main echo frequency. These temporal trapped-ion echoes are very sensitive to local turbulence. (auth)

1461 INFLUENCE OF FINITE MAGNETIC FIELD STRENGTH ON ELECTROSTATIC WAVES IN BOUNDED PLASMAS. Lee, Kai Fong (Catholic Univ. of America, Washington, D. C.). J. Appl. Phys., 40: 4537-40(Oct. 1969).

A quantitative calculation showing the dependence of the effective density for electron waves on the confining magnetic field strength is given. The effect of a noninfinite magnetic field on ion wave propagation is also investigated. (auth)

1462 EXPERIMENTAL STUDY OF TONKS–DATTNER RESONANCES IN RARE-GAS PLASMAS. Hart, D. A.; Oleson, N. L. (Naval Postgraduate School, Monterey, Calif.). J. Appl. Phys., 40: 4541-53(Oct. 1969).

Tonks–Dattner resonances were studied in active discharges of neon, argon, and xenon in the m torr pressure region where self-excited moving striations are also present. The observed resonance peaks are fewer and broader than have been reported for mercury vapor discharges. The broadening is considerably greater than expected from Landau damping and Coulomb collisions and is attributed to electron density variations associated with moving striations. Direct measurements of electron densities and electron temperatures under resonance conditions permit comparison with the theory of Nickel, Parker, and Gould with no adjustable parameters. The agreement is satisfactory for argon and xenon but the high operating pressure required for stable operation of the neon plasma invalidates the use of the free fall hypothesis and the experimental resonance frequency peaks in this case lie appreciably above the predictions of the theory. (auth)

1463 ION–ACOUSTIC OSCILLATIONS IN AN INHOMOGENEOUS PLASMA. Vlasov, M. A. Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 10-15(July 1969).

Translated from Zh. Tekh. Fiz., 39: 18-26(Jan. 1969).

A study was made of particle motion across a magnetic field and ion–acoustic oscillations in a low-pressure arc discharge (4×10^{-4} to 10^{-2} torr). Possible reasons for the instability are discussed. (auth)

1464 TIME-OF-FLIGHT STUDIES OF PROPAGATING ELECTRON PLASMA WAVES IN TONKS–DATTNER RESONANCES. Aksornkitti, S.; Hsuan, H. C. S.; Lonngren, K. E. (Univ. of Iowa, Iowa City). Phys. Rev., 186: 160-4(Oct. 5, 1969).

A series of time-of-flight experiments designed to investigate propagating electron plasma waves in a dc mercury-vapor discharge based upon the development of a phase-coherent nanosecond sine-wave burst is described. Signals of appreciable amplitude are observed to propagate with a finite velocity on the order of the electron thermal velocity and can be damped by increasing the electron neutral collision frequency. Multiple reflections of the signal are also detected. (auth)

1465 WAVE DAMPING IN PLASMA DUE TO SCATTERING BY ION SOUND WAVES. Gratzl, H. (Univ. of Maryland, College Park). Phys. Rev., 186: 225-30(Oct. 5, 1969).

When high-frequency waves in a plasma are scattered by an enhanced spectrum of low-frequency waves, they lose energy if the resulting secondary waves are Landau damped. Such a nonlinear energy loss of longitudinal waves was calculated hydrodynamically by Sturrock. However, the Vlasov equation gives a more intense scattering. Thus, a wide spectrum of ion sound waves prevents a weak two-stream instability of electron plasma waves more easily than according to the hydrodynamic calculation. If the wave vectors of the ion sound waves are shorter than the width of the instability, the scattering of secondary waves becomes decisive: Electron plasma waves diffuse in $\vec{k}$ space and the nonlinear stabilizing effect is reduced. Also, transverse high-frequency waves are nonlinearly damped, but less so by a relativistic order at least. (auth)

1466 INCOHERENT REFLECTION OF ELECTROMAGNETIC WAVES FROM A PLASMA. Kotsarenko, N. Ya.; Fedorchenko, A. M. (Kiev State Univ.). Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 27-31(July 1969).

Translated from Zh. Tekh. Fiz., 39: 42-8(Jan. 1969).

The present work is concerned with the effect of surface waves on the incoherent reflection of electromagnetic waves from a vacuum–plasma interface. An expression describing the polarization and the angular and spectral distributions of incoherent scattered radiation is derived. An estimate of the incoherent reflection coefficient for normal incidence of a naturally polarized wave on a metal surface indicates that the numerical value can be checked experimentally. (auth)

Shielding

Refer also to abstracts 487, 1682, and 1982.

1467 (GA–9438) NEUTRON ATTENUATION IN SOME SELECTED NONHYDROGENOUS MEDIA. Goetzmann, C. A. (Gulf General Atomic, Inc., San Diego, Calif.). Aug. 28, 1969. Contract AT(04-3)-167. 46p. Dep. CFSTI.

Transport calculations using the 1DF code in a P_3-S_{16} mode were performed to describe the neutron attenuation in nonhydrogenous media such as carbon, aluminum, iron, lead, and dry sand. One-dimensional calculations were done for slab shields placed adjacent to a slab–volume source containing a uniform distribution of fission sources. Twenty-six energy groups were employed to represent the neutron spectrum over the entire range from thermal to fission energies. Results are presented as plots of the relative attenuation of flux and dose rate as a function of shield thickness. Some comparisons are made with other published data. Neutron buildup factors defined by analogy to gamma-ray theory are calculated and presented in graphical form. Their usefulness is discussed. (auth)

1468 (NYO–910-131) SPECTRA OF HIGH-ENERGY ELECTRON BEAMS IN WATER. Kessaris, Nikitas D. (Sloan-Kettering Inst. for Cancer Research, New York. Div. of Biophysics). [1969]. 13p. Dep. CFSTI.

The spectra of electrons in the energy range 10 to 20 MeV incident on water are obtained theoretically by solving the appropriate transport equation by the moment method. The spectra of the primary (incident) electrons as a function of depth are obtained first, and they subsequently serve as the source of secondaries for which an analogous equation is solved. (auth)

1469 ZASHCHITA OT GAMMA-IZLUCHENIYA ISTOCHNIKOV TSILINDRICHESKOI FORMY. (Shielding of Cylindrical Gamma-Ray Sources). Osanov, D. P.; Kovalev, E. E. Moscow, Atomizdat, 1968. 120p.

The method for determination of shielding thickness is presented. On the basis of the method, nomograms were constructed that permit thickness determinations for various materials, considering the specific activity, radiation energy, and geometric parameters of the source. Use of the nomograms is illustrated by a series of examples. The book is intended for specialists working with various gamma sources. (tr-auth)

Solid-State Physics

Radiation Effects

Refer also to abstract 1277.

1470 NATURAL DIAMOND LUMINESCENCE EXCITATION BY γ-QUANTA. Mirzaev, M. R.; Khaidarov, A. A. Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 3, 71-3(1969). (In Russian).

The influence of the hardness and intensity of γ rays on the luminescence of diamonds was studied, and the mechanism of luminescence excitation was analyzed. Visual observations indicated that the luminescence color in γ-irradiation by radioisotopes was identical to the effects of x and uv irradiation. The use of a ^{170}Tm significantly increases the fluorescence intensity. An increase of voltage from 30 to 50 eV raised the fluorescence intensity 2.5 fold. Tabulated data are given on the luminescence excitation by soft components of γ rays from ^{181}W, ^{241}Am, ^{170}Tm, and ^{133}Ba. A 0.25-mm aluminum filter placed between the γ beam and the diamond reduced the fluorescence intensity by 40%. It was found that luminescence was produced, not by absorption of γ quanta, but by ejection of high-energy photoelectrons which were rapidly absorbed by diamond, resulting in the knockout of ions and induced luminescence. (R.V.J.)

1471 GAMMA RADIATION EFFECTS ON ELECTRIC CONDUCTIVITY OF ROCHELLE SALTS AND AMMONIUM DIHYDROPHOSPHATE. Azizov, S. A.; Gafurov, Kh. M. (Tashkent State Teachers Inst.). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 3, 81(1969). (In Russian).

Gamma radiation effects on the electric conductivity of the Rochelle salt and ammonium dihydrophosphate (ADR) were studied at room temperature to 2000°C, using $5 \times 5 \times 3$ mm crystals of Rochelle salts irradiated with γ rays at 6.8×10^5 r/hr and ADR irradiated at 12.6 Mr/hr. At room temperature, the electric con-

ductivity of ADR changed very little, while in Rochelle salts it increased from 1.4×10^{-10} ohm^{-1} · cm^{-1} for nonirradiated to 1.6×10^{-6} ohm^{-1} cm^{-1} in specimens irradiated with 80 Mr. A linear dependence of electric conductivity was observed up to 40 Mr in Rochelle salt and up to 200 Mr in ADR. (R.V.J.)

1472 ENDOR STUDIES OF HYDROGEN BONDING OF THE $(AsO_4)^{4-}$ CENTER IN X-RAY IRRADIATED KH_2AsO_4. Dalal, N. S.; McDowell, C. A.; Srinivasan, R. (Univ. of British Columbia, Vancouver, Can.). Chem. Phys. Lett., 4: 97-100(Oct. 1, 1969).

The technique of electron-nuclear double resonance (ENDOR) was applied to study the hydrogen-bond network around the $(AsO_4)^{4-}$ center in x-irradiated KH_2AsO_4. ENDOR transitions from several sets of hydrogen nuclei surrounding the center were observed at 4.2°K and the spectra for two sets of neighboring nuclei are identified. The angular dependences for these spectra are fitted with a spin-Hamiltonian to obtain the isotropic and anisotropic magnetic hyperfine constants. The results are discussed in terms of the available spectroscopic and crystallographic data on KH_2AsO_4 and the order–disorder model of ferroelectricity in this class of crystals. (auth)

1473 X-RAY-INDUCED CURRENTS IN ANTHRACENE AND TETRACENE. Turiel, I.; Kallmann, H. (New York Univ., N. Y.). Z. Naturforsch., 24a: 1347-52(Sept. 1969).

A new method, which avoids making measurements or applying an external voltage while the x rays are on, was used in investigating the ionization process by x rays in organic crystals (tetracene and anthracene). The following results were obtained: The x-ray-induced current is linear with electric field strength over a large range of field strengths and saturates at field strengths above 10^4 V/cm; it is proportional to the intensity of irradiation and to the thickness of the sample for the same field strength; about 1500 eV are required to produce one charge pair in anthracene and 400 eV in tetracene. It was also found that the saturation field strength is independent of the x-ray intensity (the intensity was varied by a factor of ten). From these results, it was concluded that recombination occurs mostly between the electron and the hole from which it was separated. It was also found that a large x-irradiation (8×10^5 ergs absorbed) produces trapping sites in the bulk of the crystal that trap charges and thus produce some bimolecular recombination. (auth)

1474 11.6-μ OXYGEN-ASSOCIATED ABSORPTION BAND IN NEUTRON-IRRADIATED SILICON. Cheng, L. J.; Vajda, P. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Appl. Phys., 40: 4679-80(Oct. 1969).

A study was made of the production and uniaxial stress response of the oxygen-associated defect causing the 11.6-μ band in neutron-irradiated Si. The irradiation of Ga-doped Si crystals was carried out in a fission neutron flux, and infrared spectra were measured in the 9- to 13-μ region. The intensity of the 12-μ band (A center) increases linearly with neutron flux, while that of the 11.6-μ band reaches a maximum at $\sim 7.0 \times 10^{16}$ n/cm^2. The application of uniaxial stress produces dichroism in the 12-μ band, but not in the 11.6-μ band. The results suggest that the defect is in the form of an A center (oxygen–vacancy pair) with additional oxygen or other impurity atoms nearby. (D.L.C.)

1475 35°K ANNEALING IN ELECTRON-IRRADIATED N-TYPE GERMANIUM. Bourgoin, J.; Mollot, F. (Faculte des Sciences, Paris). Phys. Lett., 30A: 264-5(Oct. 20, 1969).

The 35°K annealing stage in highly doped n-type germanium irradiated with electrons was studied and interpreted as a vacancy–"interstitial impurity" annihilation through diffusion of the interstitial. (auth)

1476 A STUDY OF ELECTRON RADIATION DAMAGE IN GaAs, GaP, AND $GaAs_{1-x}P_x$ BASED ON RECOMBINATION RADIATION. Esposito, Ralph Michael. Providence, Brown Univ., 1968. 159p.

Thesis.

The results of a study of electron bombardment-induced radiation damage in GaAs, GaP and $GaAs_{1-x}P_x$ single crystals based on monitoring the recombination radiation (cathodoluminescence spectrum) of these materials is presented. The electrons which produced the damage were supplied by a 450-keV Van de Graaff accelerator. Irradiations were performed at liquid nitrogen or liquid helium temperatures. The temperature dependence of the cathodoluminescence spectrum was established in n- and p-GaAs. The changes in the spectra resulting from exposure to electrons of sufficient energy to cause atomic displacements consisted only of reductions in the intensity of all lines in the pre-irradiation spectra, i.e., no new lines or bands associated with radiative transitions involving the centers introduced by irradiation were found in any of the materials. The thresholds for damage, i.e., the minimum electron energy needed to bring about a detectable change in the intensity of emission under constant excitation conditions, were between 275 and 300 keV for both n- and p-GaAs; between 125 and 150 keV for GaP and between 150 and 175 keV for $GaAs_{1-x}P_x$ ($x = 0.7$ and 0.54). These values correspond to 11.6 eV transferred to the Ga atom in GaAs; 11.1 eV transferred to the P atom in GaP; and 13.4 eV transferred to the P atom in the mixed crystals. The threshold for damage and the damage rates were essentially the same for (111) and ($\bar{1}\bar{1}\bar{1}$) faces of GaAs, while in the case of GaP there was a difference in degradation rates for these two crystalline orientations with the (111) face degrading somewhat faster. The degradation rates as a function of electron energy were compared to the Mott–McKinley–Feshbach formulation and were generally found to give good qualitative agreement. An estimate of the capture cross sections of the radiation defects was made and the values were in the range between 3×10^{-17} to 2×10^{-15} cm^2 for the various materials involved. The thesis also includes a brief review of previous work on radiation damage in solids and discusses the relative merits of recombination radiation studies as a means for studying radiation damage in semiconductors. (Disser. Abstr.)

1477 ELECTRON MICROSCOPE INVESTIGATION OF DAMAGE STRUCTURE IN GALLIUM ARSENIDE BOMBARDED WITH NEON IONS. Mazey, D. J.; Nelson, R. S. (Atomic Energy Research Establishment, Harwell, Eng.). Radiat. Eff., 1: 229-39(Sept. 1969).

Transmission electron microscopy studies of thin films of gallium arsenide showed that the surface regions become noncrystalline (i.e., amorphous) after bombardment at 21°C with ^{20}Ne ions of energies between 40 and 100 keV. This effect occurs after ion doses of about 1×10^{15} ions cm^{-2} and the damaged material recrystallizes onto the underlying single crystal in an apparently epitaxial manner during post-bombardment annealing at temperatures between 270°C and 300°C. Annealing at temperatures up to ~700°C in an inert atmosphere causes growth of dislocation loops which result from the initial damage structure. These dislocations were not studied in detail due to the occurrence of complicating structure resulting from the dissociation of GaAs at temperatures above ~400°C. GaAs bombarded with $\sim 3 \times 10^{16}$ 60-keV ^{20}Ne ions cm^{-2} while held at different temperatures between 35° and ~200°C contained a dense network of dislocations and dislocation loops, but did not become amorphous. However, bombardment at 40°C with 10^{17} 60-keV ^{20}Ne ions cm^{-2} did produce an amorphous surface phase. (auth)

1478 BEHAVIOR OF LOW-TEMPERATURE IRRADIATED CADMIUM. Maury, F.; Lucasson, A.; Lucasson, P. (Laboratoire de Chimie Physique, Orsay, France). Radiat. Eff., 1: 241-8(Sept. 1969).

The atomic displacement process in electron-irradiated cadmium was studied. The experimental data can be fitted, using an energetic threshold for Frenkel pair formation $T_d = 19$ eV. Discussion of the nonlinearity of the resistivity increase per electron versus total electron flux shows that this behavior may be explained by the existence of a very unstable Frenkel pair species, the mutual annihilation of which may be initiated either thermally at ~5.5°K after the irradiation, or dynamically. In the latter case, the most important events for producing pair annihilation would be elastic interactions of secondary electrons with the atomic nuclei. With regard to the high c/a ratio in cadmium, clues exist showing that these unstable defects are likely to be Frenkel pairs situated in and interacting through densely packed atomic rows in the basal planes. (auth)

1479 EVIDENCE OF A REPLACEMENT REACTION BETWEEN ION IMPLANTED SUBSTITUTIONAL Tl DOPANTS AND INTERSTITIAL Si ATOMS. Fladda, G.; Mazzoldi, P.; Rimini, E.; Sigurd, D.; Eriksson, L. (Research Inst. for Physics, Stockholm). Radiat. Eff., 1: 249-56(Sept. 1969).

The lattice location of implanted Tl atoms in Si was studied by means of the channeling technique. A motion from substitutional sites into the tetrahedral interstitial sites along the ⟨111⟩ rows is observed under carbon bombardment at temperatures around 300°C. It is concluded that this motion is due to an indirect process associated with the carbon bombardment. It is suggested that Si interstitial atoms created during bombardment diffuse to substitutional Tl atoms and displace them into interstitial sites in a Watkins-type replacement reaction. A strong temperature dependence is observed, and the process appears to be thermally activated. No effect is detectable (i) for a room temperature bombardment or (ii) for a 340°C bombardment of a Tl implant that contains a majority of implanted substitutional As dopants. The lattice location of implanted Tl atoms depends markedly on implantation temperature and dose for the temperature region used in earlier

studies (350 to 450°C) there is nearly a 1:1 relation between substitutional and interstitial fractions. (auth)

1480 DEFECTS OBSERVED BY ELECTRON MICROSCOPY IN GOLD BOMBARDED WITH keV GOLD IONS. I. NATURE OF DEFECTS. Thomas, L. E.; Schober, T.; Balluffi, R. W. (Cornell Univ., Ithaca, N. Y.). Radiat. Eff., 1: 257-68(Sept. 1969).

The nature of small defect clusters produced in single-crystal gold films by room temperature bombardment with 3- to 40-keV gold ions incident along [001] channeling directions to doses of 10^9 to 10^{12} ions cm^{-2} was investigated using transmission electron microscopy. The number of observed defects per measured incident ion rose from about 0.03 at 3 keV to ~1 defect per ion for ion energies >10 keV. Above 15 keV, closely spaced groups of multiple clusters produced by individual ions were observed in significant numbers. Stereo microscopy showed that essentially all of the defects were produced within about 300 Å of the bombarded surface. Application of the defect contrast analysis of Wilkens and Rühle for identifying the nature of small defects revealed that the visible defects were vacancy type over the entire range of ion energies used. Above 15 keV the defects were mainly dislocation loops; below 15 keV they appeared to be centers of dilatation. These results are contrasted with observations by Diepers, and Diehl et al. of interstitial dislocation loops in copper and gold bombarded with 1-5 keV argon ions and with previous work (Merkle, and Noggle and Oen) suggesting that a threshold knock-on energy of about 25 keV exists for the formation of a visible cluster in gold. Finally, models are proposed for the production of defect clusters in ion-bombarded gold as a function of incident ion energy and specimen purity. (auth)

1481 DEFECTS OBSERVED BY ELECTRON MICROSCOPY IN GOLD BOMBARDED WITH keV GOLD IONS. II. MECHANISM OF DEFECT FORMATION. Thomas, L. E.; Schober, T.; Balluffi, R. W. (Cornell Univ., Ithaca, N. Y.). Radiat. Eff., 1: 269-78(Sept. 1969).

Further electron microscopy studies were made of the vacancy-type defects produced in gold thin films by keV gold ion bombardment along channeling directions at room temperature as described in Part I. It was found that the defect density increased linearly with dose, and that the defect size distribution was independent of dose for a given ion energy. The average defect size increased with increasing ion energy. Measurements of the defect depth distributions below the surface were also made for bombardment along a fixed direction (i.e.[001]) as a function of energy (5 to 20 keV) and for bombardments of fixed energy (40 keV) as a function of channeling direction (i.e.[111], [001], and [011]). The distributions were all sharply peaked below the surface. It was concluded that serious glissile defect losses to the surface occurred within 100 to 200 Å of the surface. Considerable evidence in the literature supporting this conclusion was cited. The defect depth distributions in the regions unaffected by surface losses were compared with the corresponding ion penetration data, and reasonably good agreement was found. The results indicated that: (1) essentially all of the observed defects were produced beyond the range of randomly colliding incident ions and were therefore caused by channeled gold ions; (2) the defects were formed in situ at displacement cascades initiated by the dechanneling of incident channeled gold ions by thermally displaced atoms; (3) the stopping of channeled gold ions in gold at room temperature by dechanneling at thermally displaced atoms is a major stopping mechanism in the energy range where nuclear stopping is important. (auth)

1482 DEFECTS OBSERVED BY ELECTRON MICROSCOPY IN GOLD BOMBARDED WITH keV GOLD IONS. III. STEREO STUDY OF SUBCASCADE CLUSTER GEOMETRIES. Schober, T.; Thomas, L. E.; Balluffi, R. W. (Cornell Univ., Ithaca, N. Y.). Radiat. Eff., 1: 279-87(Sept. 1969).

The geometrical arrangement of visible subcascade defect clusters (i.e., subclusters) formed in large displacement cascades was investigated in single-crystal gold films after 120-keV gold ion bombardment at 295°K along [001] using electron stereomicroscopy. It was concluded that the subclusters were vacancy-type defects formed in situ at vacancy-rich subcascade regions in displacement cascades as described in Parts I and II. Measurements were made of the sizes and separations of the subclusters in 69 cascade regions, each of which contained either two or three subclusters. The angular directions of the lines constructed between subcluster centers in each cascade were also measured. The observations were consistent with a model in which the first subcluster was produced at a subcascade resulting from the dechanneling of an incident ion which was initially channeled along [001]. Further subclusters were then formed by either the deflected incident ion or by energetic knockons. It was concluded that a substantial portion of the total energy of the incident ion was used to produce the subcascades responsible for the visible subclusters. Also, many of the energetic particles which produced the subcascades must have been quasi-channeled. (auth)

Physical Properties

1483 (CEA-R-3859) MAGNETIC STUDY OF SOLID FLUORINE-CONTAINING COMPOUNDS OF URANIUM. Dianoux, Albert-Jose (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Aug. 1969. 147p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Lyon Univ., France.

A study of the magnetic susceptibility of uranium(V) fluorine complexes and of the magnetic resonance of fluorine atoms in uranium(VI) fluorine complexes has made it possible to put forward a structural model for these compounds for which it is impossible, because of the lack of suitable single crystals for x-ray diffraction work, to deduce the exact position of the fluorine atoms. It is shown that it is difficult to interpret the paramagnetism of uranium fluorides, because the uranium ions are in low-symmetry sites. A theoretical study of the magnetism of the U^V ion in complex fluorides of the type M_3UF_8 (M = NH_4, Na, Rb, Cs) leads to an interpretation based on a trigonal deformation of the eight fluorine atom structure surrounding the uranium atom. By applying a Hamiltonian spin formalism and making a systematic use of group theory, it is possible to present the susceptibility calculations very concisely. Study of the resonance and of the relaxation of the fluorine atoms in powdered uranium(VI) complex fluorides suggests a structural model in the case of $NaUF_7$. It is shown that the shape of the magnetic resonance absorption lines is strongly affected by the presence of large anisotropic chemical shifts. In the model proposed, six fluorine atoms are linked to the uranium atom by strongly covalent bonds in a deformed UF_6 octahedral structure; the seventh fluorine atom remains ionic. The occurrence of a rotational movement of the octahedron is confirmed by a study of the longitudinal relaxation of the fluorine atoms, the activation energy being 0.46 eV. (auth)

1484 (TID-25248) MAGNETIC PROPERTIES OF BINARY RARE EARTH ALLOYS. Millhouse, Arthur Holmes (Virginia Polytechnic Inst., Blacksburg). Sept. 1969. 135p. Dep. CFSTI.

Thesis.

Single-crystal samples of Ho–Dy, Er–Gd, Er–Tb, Er–Dy, and Ho–Er alloys were prepared using the strain-anneal technique. Neutron diffraction studies of these samples were made from room temperature to 4.2°K to determine their magnetic structure properties. In most cases, a detailed study of the intensities of several important reflections were made as a function of temperature. The temperature dependence of the ordered atomic moment and its projections along the c axis and upon the crystal basal plane were calculated, using the magnetic structure models proposed for the pure metals. For the alloys, these models are found to be satisfactory. In the alloy systems Er–Tb, Er–Dy, and Ho–Er, the best agreement with the measured moment values is obtained by assuming that the Tb, Dy, or Ho moments are parallel to the Er moments within hexagonal layers at 4.2°K. This implies that the "multimoment" anisotropies dominate in these systems and that anisotropic exchange is probably an important source of the anisotropy. The observations made on the alloys appear to be generally explicable by the combination of exchange and anisotropy used for the pure metals. The existence of a sinusoidal c-axis oscillation at a lower temperature than the helical configuration is not, however, predicted by molecular field theory arguments. (auth)

1485 INELASTIC SCATTERING CROSS SECTION OF NEUTRONS IN FERROELECTRICS. Jaiswal, V. K.; Sharma, P. K. (Univ. of Allahabad, India). Physica, 44: 69-80(Sept. 8, 1969).

An expression is obtained for the one-phonon differential scattering cross section of neutrons coherently scattered from a ferroelectric crystal using the method of double-time Green functions. This has been derived from a Hamiltonian propounded by Nettleton which considers fourth-order anharmonic terms in the lattice energy. It is shown that, due to the introduction of higher order anharmonic terms, the scattering function is no longer a two-delta function but has a Lorentzian shape. The width and the shift in the frequency are obtained. (auth)

1486 PHYSICAL MEASUREMENT AND ANALYSIS OF THIN FILMS. Eastern Analytical Symposium Held in New York City, November 8–10, 1967. Murt, E. M.; Guldner, W. G. (eds.). Progress in Analytical Chemistry, Volume 2. New York, Plenum Press, 1969. 203p. $12.50. (CONF-671146).

Eight papers are included which were presented at the conference. They cover nondestructive optical techniques for thickness measurements, a review of x-ray methods, x-ray fluorescence and electron microprobe techniques, density of sputtered Ta films,

electron microscopy and diffraction, emission spectrographic and atomic-absorption analysis, rf spark-source mass spectrometry, and evaluation of glass films. An index is provided. (D.L.C.)

1487 COLOR CENTERS IN ALKALI HALIDES. 1968 International Symposium, Rome, September 23–27, 1968. Rome, Consiglio Nazionale delle Ricerche, 1968. 323p. (CONF-680902).

Summaries of 202 papers presented at the conference are included. Some of the topics covered are: band structure, impurity centers, radioinduced defects, electron excess centers, excitons, F-aggregate centers, hole excess centers, effects of external perturbation, luminescence, non-alkali halides, magnetic properties (ESR, ENDOR), phonon interactions, and transport properties. Author and subject indexes are included. (D.L.C.)

1488 HIGH-RESOLUTION FIELD ION MICROSCOPY. Tong, Hua-ching. Urbana, Ill., Univ. of Illinois, 1968. 137p. Thesis.

Defects induced on both the surfaces and the interiors of tungsten wires have been studied. Atomic rearrangements on the surfaces caused by strong electric fields have been observed. The fine structures of atomic groupings (metastable molecules) at special sites have been resolved for the first time. The groupings are classified as triplets, quadruplets, quintuplets, and higher orders. Tungsten specimens were bombarded inside the field ion microscope with energetic helium atoms (with kinetic energies ranging from 100 eV to 5 keV). Some specimens were rotated to place their axes parallel with the ion beam during the bombardment. Others were bombarded in the usual way from the side. Defects generated by the helium ion bombardment were identified as vacancies, interstitials, and vacancy clusters. Low-temperature interstitial migration was observed between 10°K and 50°K. Grain boundaries acting as sinks for interstitials were also observed. Finally, the sputtering threshold energy for a field ion tip has been measured. Point defects and stacking faults on {110} with partial dislocation of $\frac{1}{8}$ a ⟨110⟩ were found in tungsten. (Disser. Abstr.)

Moessbauer Effects and NMR

1489 A CALORIMETRIC MEASUREMENT OF THE NUCLEAR QUADRUPOLE COUPLING IN PURE SINGLE-CRYSTAL RHENIUM METAL. Rockwood, S. D.; Gregory, E. H.; Goodstein, D. L. (California Inst. of Tech., Pasadena). Phys. Lett., 30A: 225-6(Oct. 20, 1969).

The nuclear contribution to the specific heat of Re was measured in the temperature range 0.1 to 0.5°K. The nuclear contribution has the expected A/T^2 dependence. It was found that $A = 0.061 \pm 0.002$ mJ°K/mole for $H \gtrsim H_c$, increasing to $A = 0.077 \pm 0.004$ mJ°K/mole at H = 12.5 Oe. On the basis of these results, the resonant magnetic fields for possible NMR transitions are predicted. (auth)

1490 TEMPERATURE DEPENDENCE OF THE HYPERFINE INTERACTIONS OF FeB. Jeffries, J. B.; Hershkowitz, N. (Univ. of Iowa, Iowa City). Phys. Lett., 30A: 187-8(Oct. 6, 1969).

The temperature dependence of the hyperfine interaction at iron nuclei in ferromagnetic FeB was measured. The relative magnetization was found to be described by $(1 - T/T_c)^{\beta}$ where $\beta = 0.545 \pm 0.010$ for $4 \times 10^{-4} < (1 - T/T_c) < 1.3 \times 10^{-1}$. (auth)

Theoretical Physics

Refer also to abstract 1680.

1491 ON THE COMPARISON BETWEEN THE GREEN FUNCTION METHOD AND THE KINETIC APPROACH TO THE IMPURITY RESISTANCE IN QUANTUM SYSTEMS. I. THE GENERAL EQUATIONS. Dewel, G. (Univ. Libre, Brussels). Physica, 44: 120-42(Sept. 8, 1969).

The kinetic theories of Prigogine and Van Hove as well as the Green function method (perturbation theory and equation of motion methods) are applied in a rather unified way to the derivation of transport equations for the electron-impurity model with the aim to study the relationship between these various approaches in the next paper. (auth)

1492 PATTERN RECOGNITION AND STATISTICAL MECHANICS. Richardson, John M. (North American Rockwell Corp., Thousand Oaks, Calif.). J. Statist. Phys., 1: 71-88(1969).

A mathematical connection is established between classes of problems in pattern recognition and in statistical mechanics. More explicitly, the former class embraces problems arising from the decision-theoretic approach to the automatic recognition of certain properties of patterns containing many targets. The latter class contains almost all problems involving the statistical mechanics of classical systems of interacting particles. The usefulness of the mathematical connection lies in the fact that it provides a bridge for the transfer of approximation methodologies from one area to the other. As examples of such a transfer this paper presents applications of a least mean square approximation method, which is well known in pattern recognition, to two problems in classical statistical mechanics, namely, the one-dimensional Ising problem and the one-component plasma problem. These problems were chosen because their solutions are well understood (the exact solution of the one-dimensional Ising model and the solution of the one-component plasma that is exact in the low concentration limit are both very well known) and consequently they are appropriate as "test beds" for the new approximation method. The simplest nontrivial approximate trial functions were used for the calculation of the average values of certain observables and the results were in agreement with the corresponding exact results for the Ising model in the limit of high temperature and for the one-component plasma in the limit of low concentration. (auth)

1493 QUANTUM STATISTICAL MECHANICS OF SYSTEMS WITH AN INFINITE NUMBER OF DEGREES OF FREEDOM. Prigogine, I. (Univ., Brussels, Univ. of Texas, Austin). pp 315-31 of Contemporary Physics: Trieste Symposium 1968, Vol. I. Vienna, International Atomic Energy Agency, 1969.

From International Symposium on Contemporary Physics, Trieste, Italy. See STI/PUB-214(Vol.1); CONF-680629(Vol.1).

The topics are discussed in the following order: (1) introduction; (2) master equations and kinetic equations; (3) invariant manifold of the dynamic evolution; (4) quantization and physical states on the invariant manifold; and (5) conclusions and applications. (M.O.W.)

1494 NOTE ON CORRELATION ENERGY OF THE ELECTRON GAS. Ferreira, Lidia (Univ., Coimbra). Port. Phys., 5: 119-22(1968).

An attempt is made to describe the correlation structure of the electron gas in terms of the collective modes only. A very simple formalism is obtained which leads to very good agreement with the results of Nozières–Pines and of Hubbard for low momentum transfer ($k/k_F < 1$), if one neglects the exchange terms. (auth)

1495 CALCULATION OF TRAJECTORIES OF CHARGED PARTICLES IN COMBINED ELECTRIC AND MAGNETIC FIELDS POSSESSING AXIAL SYMMETRY. Grigorishin, I. L.; Dubrovenskaya, I. E. (Minsk Radiotechnical Inst.). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Tekh. Navuk, No. 2, 71-5(1969). (In Russian).

Approximate methods for calculation of trajectories of relativistic charged particles are considered for given distributions of potential and magnetic flux in the nodal points of different meshes. On the basis of these distributions the values of equivalent potentials are determined, which are the algebraic sums of the effective potentials and potentials which consider the action of external longitudinal magnetic fields. Trajectories are calculated by two methods for the r, z plane, which is rotated with a velocity equal to the angular velocity of the electrons. The first is based on a premise concerning the homogeneity of the field in a unit square of the different meshes; the second is based on the solution of the Dirichlet problem for rectangles whose peaks coincide with the nodal points, and on the conditions that the neighboring-point potentials differ little from each other and the potential distribution on the side of the rectangle is linear. The expressions developed are convenient for calculation of trajectories with electronic computers. (tr-auth)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Electromagnetic

1496 INELASTIC ELECTRON–PROTON SCATTERING AT FIXED FOUR-MOMENTUM TRANSFER OF 0.773 AND 1.935 $(GeV/c)^2$. Albrecht, W. (Deutsches Elektronen-Synchrotron, Hamburg); Brasse, F. W.; Dorner, H.; Flauger, W.; Frank, K. H.; Gayler, J.; Hultschig, H.; May, J.; Ganssauge, E. Nucl. Phys., B13: 1-8(1969).

Inelastic e-p scattering measurements were performed at fixed four-momentum transfers of $q^2 = 0.773$ and 1.935 $(GeV/c)^2$ and at scattering angles of $\theta = 47.8°$ and 76.0°. The results are compared with predictions for inelastic e-p scattering. (auth)

1497 PHOTOPRODUCTION OF CHARGED PION PAIRS ON PROTONS. Alvensleben, H.; Becker, U.; Bertram, William K.; (and others) (Deutsches Elektronen-Synchrotron, Hamburg. Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett., 23: 1058-63(Nov. 3, 1969).

A high-statistics (100,000 events) measurement of photoproduction of charged pion pairs on protons is reported in two parts. First, the measured cross sections are presented in a three-dimensional data matrix where all the dynamical features are explicitly shown. Second, fitting the data in the energy region 2.6 to 6.8 GeV with various assumptions on ρ production indicates that $d\sigma/dt|_{t=0}$ for the photoproduction of ρ decreases with increasing energy similar to πN scattering. (auth)

1498 A SEARCH AT THE ZENITH FOR 200 MHz AND 3000 MHz RADIO EMISSION FROM EXTENSIVE AIR SHOWERS. Charman, W. N.; Jelley, J. V. (Atomic Energy Research Establishment, Harwell, Eng.). Nuovo Cim., 63B: 473-85(Oct. 11, 1969).

Extensive air showers of energy $>2.10^{15}$ eV were detected by either Čerenkov night-sky light receivers or by a small array of liquid scintillators. Coincident radio pulses were observed at 200 MHz, the results apparently suggesting an incoherent emission mechanism; only slight evidence was obtained for any corresponding 3000 MHz emission. The results are discussed in terms of possible mechanisms for production by showers of radiation at these frequencies. (auth)

1499 MULTIPLE-SCATTERING DISTRIBUTIONS AT LONG CELL LENGTHS. Kamal, A. A.; Rao, G. K.; Rao, Y. V. (Osmania Univ., Hyderabad, India). Nuovo Cim., 64A: 50-4(Nov. 1, 1969).

The distributions of multiple-scattering angles of 17.2 GeV/c π^- tracks in photographic emulsion are compared with Molière's theory. It is concluded that the discrepancies between the observed and expected scattering constants at large cell lengths are not due to losses of large-angle scatters due to nuclear interactions but due to finite-size effects which are not taken into account in Molière's theory. (auth)

1500 NEUTRON FORM FACTORS FROM QUASI-ELASTIC e-d SCATTERING. Bartel, W.; Buesser, F.-W.; Dix, W.-R.; (and others) (Deutsches Elektronen-Synchrotron, Hamburg. Univ., Hamburg). Phys. Lett., 30B: 285-8(Oct. 13, 1969).

The reaction $e + d \rightarrow e' + n + p$ was studied at electron scattering angles $\theta \leq 350°$ for four-momentum transfers of 0.39, 0.565, and 0.78 $(GeV/c)^2$. By recording electron-neutron and electron-proton coincidences, the ratio of the electron scattering cross sections on quasi-free neutrons and protons was determined. An estimate of the binding effects, based on a Chew-Low-extrapolation, was made. Values for the neutron form factors were derived. (auth)

1501 SEARCH FOR COHERENT REGENERATION FROM ELECTRONS THE K_0 CHARGE RADIUS. Foeth, H. (Technische Hochschule, Aachen); Holder, M.; Radermacher, E.; (and others). Phys. Lett., 30B: 276-81(Oct. 13, 1969).

A search was made for the coherent interactions of a long-lived neutral kaon with the electrons of lead and copper plates. Results are compatible with the absence of such effects. In terms of the kaon r.m.s. charge radius $\sqrt{\langle R^2 \rangle} = 0.22^{+\infty}_{-0.22}$ fm was found. (auth)

Weak

1502 DIRECT DETERMINATION OF $R_\rho = (K_L^0 \rightarrow \pi\mu\nu)/(K_L^0 \rightarrow \pi e\nu)$. Beilliere, P.; Boutang, G.; Limon, J. (Ecole Polytechnique, Paris). Phys. Lett., 30B: 202-3(Sept. 29, 1969).

A sample of K_L^0 mesons decaying in the CERN 1,1 m^3 heavy liquid bubble chamber is used to determine the $(K_L^0 \rightarrow \pi\mu\nu)/(K_L^0 \rightarrow \pi e\nu)$ branching ratio, that is found to be 0.71 ± 0.04. (auth)

1503 ON THE PHASE OF $\eta_+ = A(K_L \rightarrow \pi^+\pi^-)/A(K_S \rightarrow \pi^+\pi^-)$. Darriulat, P. (CERN, Geneva); Kleinknecht, K.; Rubbia, C.; Sandweiss, J.; Foeth, H.; Staude, A.; Tittel, K.; Ferrero, M. I.; Grosso, C. Phys. Lett., 30B: 209-12(Sept. 29, 1969).

The results of the preceding paper and experiments on interference between $K_L \rightarrow \pi^+\pi^-$ and $K_S \rightarrow \pi^+\pi^-$ from an initial K^0 give arg $(\eta_+) = 45.5^0 \pm 7.1^0$. Let $\epsilon'(\epsilon)$ be the K_L decay amplitudes into the $I = 2$ $(I = 0)$ $\pi\pi$ state. Combining this result with measurements of Re (ϵ) it is found that Re $(\epsilon') = -(0.07 \pm 0.20) \times 10^{-3}$. Furthermore, provided no large CP violation occurs in the leptonic and 3π decays $|\epsilon'/\epsilon| < 0.15$. (auth)

1504 SEARCH FOR $K_L \rightarrow \mu^+\mu^-$ AND $K_L \rightarrow e^+e^-$ DECAYS. Foeth, H. (Technische Hochschule, Aachen); Holder, M.; Radermacher, E.; (and others). Phys. Lett., 30B: 282-4(Oct. 13, 1969).

A search was made for the decay of the long lived kaon into muon and electron pairs. No event was found. The upper limits are $\Gamma(K_L \rightarrow \mu^+\mu^-)/\Gamma(K_L \rightarrow \text{all}) = 2.1 \times 10^{-7}$ and $(K_L \rightarrow e^+e^-)/\Gamma(K_L \rightarrow \text{all}) = 1.5 \times 10^{-7}$ with 90% confidence level. (auth)

Strong (Baryon-Induced)

Refer also to abstract 1727.

1505 (JINR-P1-4642) ESTIMATE OF THE ADMIXTURE TO THE $np \rightarrow pp\pi^-$ REACTION AT A NEUTRON MOMENTUM FROM 2 TO 10 GeV/c. Gasparyan, A. P.; Nikitin, A. V.; Troyan, Yu. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1969. 20p. Dep. CFSTI. (In Russian)

On the basis of the background available experimental data and simulation of the investigated and background reactions the admixture to the $np \rightarrow pp\pi^-$ reaction was estimated when bombarding the 50-cm propane chamber by neutrons with the momentum from 2 to 10 GeV/c. The admixture is shown to be not more than (6–14%) by the mentioned system of data processing. (auth)

1506 (PPAR-20) $n + p \rightarrow d + \gamma$ AND TIME REVERSAL INVARIANCE. Bartlett, D. F.; Friedberg, C. E.; Goulianos, K.; Hammerman, I. S. (Princeton Univ., N. J. Palmer Physical Lab.); Hutchinson, D. P. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). Aug. 6, 1969. Contract AT(30-1)-2137. 15p. Dep. CFSTI.

Measurements are reported of the differential and total cross section for $n + p \rightarrow d + \gamma$ for neutron energies between 160 and 640 MeV. A comparison is made with the differential and total cross sections for the inverse process. (auth)

1507 (UCRL-19350) EXPERIMENTAL TEST OF TIME-REVERSAL INVARIANCE IN THE PHOTODISINTEGRATION OF THE DEUTERON. Schrock, B. L.; Detoeuf, J.-F.; Haddock, R. P.; Helland, J. A.; Longo, M. J.; Young, K. K.; Wilson, S. S.; Cheng, D.; Sperinde, J.; Perez-Mendez, V. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1969. Contract W-7405-eng-48. 11p. (CONF-690503-8). Dep. CFSTI.

From 3rd International Conference on High Energy Physics and Nuclear Structure, Argonne, Ill.

A measurement using spark chambers is made of the angular distributions from the interaction $n + p \rightarrow d + \gamma$ at 300 to 700 MeV. These data are compared with data from $\gamma + d \rightarrow n + p$ interactions in order to test time reversal invariance in this interaction. (J.F.P.)

1508 THE ANNIHILATION AT REST $\bar{N}N \rightarrow K\bar{K}\pi$. Bettini, A. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua); Cresti, M.; Limentani, S.; (and others). Nuovo Cim., 63A: 1199-1200(Oct. 21, 1969).

An analysis was made of the three-body annihilations at rest $\bar{p}n \rightarrow K\bar{K}\pi$, from a total sample of $2.22 \cdot 10^5$ annihilations. The annihilation at rest $\bar{p}p \rightarrow K\bar{K}\pi$ has been studied by Conforto et al. The "multiple final-state interaction model" developed by them was used to analyze the $N\bar{N}$ annihilation; an overall consistent picture is obtained in this way. (auth)

1509 PION PRODUCTION IN HIGH-ENERGY PROTON–PROTON COLLISIONS. Day, J. L.; Johnson, N. P.; Krisch, A. D.; Marshak, M. L.; Randolph, J. K.; Schmueser, P. (Univ. of Michigan, Ann Arbor). Phys. Rev. Lett., 23: 1055-8(Nov. 3, 1969).

The differential production cross section for producing pions in 12.2-GeV/c p-p collisions on lines of fixed $P_\parallel$ and $P_\perp$ in the c.m.

system was measured. It was found that $d^3\sigma/d\Omega dP$ is maximum at $P_\parallel = 0$, in disagreement with the earlier result, which supported the two-center model. Evidence exists that the earlier result is wrong. It is suggested that in the c.m. system, $d^2\sigma/d\Omega dp$ is factorable into functions of $P_\parallel$ and $P_\perp$. In the $P_\perp$ dependence a very sharp forward peak of the form $e^{-15P_\perp}$ was found. (auth)

1510 MOMENTUM SPECTRA OF CHARGED PIONS PRODUCED IN PROTON–PROTON INTERACTIONS BETWEEN 13 AND 28.5 GeV/c. Smith, Dennis B. (Univ. of California, Berkeley); Sprafka, Robert J.; Anderson, Jared A. Phys. Rev. Lett., 23: 1064-7(Nov. 3, 1969).

Proton-proton interactions with four or more charged particles in the final state are studied over a range of incident momenta between 13 and 28.5 GeV/c. Topology cross sections are presented. The center-of-mass momentum distributions of π^+ and π^- are determined and are successfully parametrized. The π^+ and π^- momentum spectra are found to have approximately the same shape. Multiple fireball production is not required by our data. (auth)

1511 ABSORPTION CROSS-SECTIONS OF HIGH-ENERGY HADRONS ON NUCLEI. Abul-Magd, A. Y. (International Centre for Theoretical Physics, Trieste, Italy); Alberi, G.; Bertocchi, L. Phys. Lett., 30B: 182-4(Sept. 29, 1969).

The absorption cross-sections of negatively charged hadrons on nuclei, recently measured at 40 GeV/c at Serpukhov, are compared with the Glauber multiple scattering theory. (auth)

1512 SEARCH FOR FRACTIONALLY CHARGED PARTICLES USING THE CERN PROTON SYNCHROTRON. Allaby, J. V.; Bianchini, G.; Diddens, A. N.; (and others) (CERN, Geneva). Nuovo Cim., 64A: 75-94(Nov. 1, 1969).

A search was made for particles of fractional electric charge, produced at small angles from an internal Be target in the CERN Proton Synchrotron. No such particles were found; upper limits were obtained for the production cross sections (90% confidence level) for $-\frac{1}{3}e$, $-\frac{2}{3}e$, $+\frac{1}{3}e$, and $+\frac{2}{3}e$ particles at 27 GeV/c incident-proton momentum. (auth)

1513 SLOPE PARAMETER OF THE DIFFERENTIAL CROSS SECTION OF ELASTIC p–p SCATTERING IN ENERGY RANGE 12 TO 70 GeV. Beznogikh, G. G. (Joint Inst. for Nuclear Research, Dubna, USSR); Buyak, A.; Iovchev, K. I.; (and others). Phys. Lett., 30B: 274-5(Oct. 13, 1969).

The measurements of the differential cross section of elastic p-p scattering in relative units were performed in the energy range of 12 to 70 GeV. The values of the slope parameter were obtained from these data. It was shown that the slope parameter of the differential p-p scattering is monotonously increasing when the proton energy rises in the range 12-70 GeV. The slope Pomeranchuk's pole trajectory from this data: $\alpha_p' = 0.40 \pm 0.09$. (auth)

Strong (Meson-Induced)

Refer also to abstract 1597.

1514 (COO–1195-165) XI-MINUS HYPERON PRODUCTION IN K-MINUS PROTON INTERACTIONS AT 5.5 GeV/c. Schultz, Peter Frank (Illinois Univ., Urbana). 1969. Contract AT(11-1)-1195. 162p. Dep. CFSTI.

Thesis.

The results of an investigation of the production of Ξ^- hyperons in K^-p interactions at 5.5 BeV/c are presented. The data were obtained from a 400,000 picture exposure of the MURA 30'' hydrogen bubble chamber at the Argonne National Laboratory. Production cross sections for the Ξ^- final states and for the $\Xi^*(1530)$ and $K^*(890)$ resonances are given. Center of mass angular distributions in the 2, 3, and quasi-3 body final states are characterized by the forward peaking of the Ξ^-. An exception is the $\Xi^-K^+\Phi$ final state in which the Φ meson is observed to go forward in the center of mass. The $\Xi^-\pi$ distribution has evidence for the production of the $\Xi^*(1930)$ resonance. The mass and width are 1955 ± 14 MeV and 56 ± 26 MeV. A very narrow structure, $\Gamma <$ 30 MeV, at a mass of 2295 ± 15 MeV is observed in the $\Xi^-\pi^+\pi^-$ mass distribution of the 4 and 5 body final states. The mass of the Ξ^- is measured to be 1321.8 ± 0.4 MeV. Details of a search for and the identification of Ω^- hyperons are given. The mass of the Ω^- is measured to be 1671.8 ± 0.9 MeV as determined from three unambiguous cases of Ω^- production and decay. (auth)

1515 (UCRL–19339) RESONANCE PRODUCTION IN THE REACTION $\pi^+D \rightarrow PP\pi\pi$ FROM 1.1 TO 2.3 GeV/c. Manning, Robert J. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1969. 134p. Dep. CFSTI.

Thesis.

In an analysis of 229,000 pictures of π^+ at incident momenta of 1.1 to 2.3 GeV/c in the deuterium-filled 72-inch bubble chamber, 41,045 examples of the reaction $\pi^+d \rightarrow PP\pi^+\pi^-$ were identified. A phase shift analysis was attempted on the angular distribution moments of off-mass-shell π–π scattering for low momentum transfer events (production angle cosine from beam to outgoing mesons >0.8). This resulted in four distinct solutions for the I = 0, J = 0 π–π scattering phase shift. The solution which rises slowly to nearly 90° at a π–π mass of 700 MeV and remains near 90° for π–π masses between 700 and 1000 MeV is preferred over the solutions by comparison with the subtracted $\pi^0\pi^0$ mass spectrum. At values of center-of-mass energy >2.1 GeV forward peaking was found in the single meson exchange forbidden reaction $\pi^+N \rightarrow \Delta^{2+}(1238)\pi^-$. In the same reaction backward peaking was also observed inconsistent with simple J = ½ baryon exchange in the u-channel. Also there were 8433 examples of the reaction $\pi^+ + d \rightarrow 2p$ + neutrals identified. An application of the impulse approximation and the selection $1.832 < ECM < 2.285$ GeV gives 4956 events of the type $\pi^+ + n \rightarrow p$ + neutrals. At small momentum transfers (≤0.2 and 0.08 GeV^2/c^2) to the neutrals system, no direct evidence was found for an enhancement near the reported position of the ϵ^0, about 730 MeV. A detailed subtraction of $3\pi^0$ and $\Delta^+(1236)$ background based on cross sections from other experiments results in a $2\pi^0$ mass spectrum which is in disagreement with two experiments at nearly the same center-of-mass energy, and which is consistent with a $\delta_0^0\pi$–π phase shift which rises slowly to near 90° at a π–π mass of 700 MeV and remains near 90° for π–π masses between 700 and 1000 MeV. (auth)

1516 STUDY OF THE A_1 REGION IN π^-p AT 7 GeV/c. Fayolle, J. C.; de Montaignac, B.; Morand, M.; Strachman, Z.; Thibaut, H. (Faculte des Sciences, Paris). Nucl. Phys., B13: 40-4(1969).

An analysis of the missing mass spectrum obtained in $\pi^-p \rightarrow pX^-$ at 7 GeV/c is presented. In addition to the A_2 peak, a broad enhancement is seen in the A_1 region. If the four-momentum dependence is described by $d\sigma/dt$ = const. exp (–At) the value of A is 7.0 ± 1.0 for the A_2 meson and 13.9 ± 1.2 for the A_1 peak. The data were taken by the MMS group at CERN in 1967. (auth)

1517 PARTIAL WAVE ANALYSIS OF THE REACTION $\pi N \rightarrow N\pi\pi$ BELOW 1 GeV II π^+p INELASTIC INTERACTIONS. De Beer, M.; Deler, B.; Dolbeau, J.; Neveu, M.; Diem, Nguyen Thuc; Smadja, G.; Valladas, G. (CEN, Saclay, France). Nucl. Phys., B12: 617-26(1969).

The reaction $\pi^+p \rightarrow p\pi^+\pi^0$ is analysed in terms of partial wave amplitudes for isobar production. The agreement with phase-shift analyses is generally good except for P31 and S31 waves. (auth)

1518 OBSERVATION OF REGGE EFFECTS IN THE REACTION $\pi^+p \rightarrow \pi^0\Delta^{++}$. Gidal, G. (Univ. of California, Berkeley); Borreani, G.; Grether, D.; Lott, F.; Birge, R. W.; Fung, S. Y.; Jackson, W.; Poe, R. Phys. Rev. Lett., 23: 994-8(Oct. 27, 1969).

A measurement is reported of the total and differential cross sections and Δ^{++}-decay angular distributions for the reaction $\pi^+p \rightarrow \pi^0\Delta^{++}$ at incident momenta between 2.67 and 4.08 GeV/c. A dip near $t = -0.5$ and a backward peak are clearly observed. In a Regge pole exchange model the parameters of the ρ trajectory are determined. (auth)

1519 REACTION $\pi^-p \rightarrow \pi^0n$ NEAR 180° AT HIGH ENERGIES. Schneider, J. (Institut de Physique Nucleaire, Orsay, France); Lepeltier, V.; Bonamy, P.; Borgeaud, P.; Guisan, O.; Sonderegger, P. Phys. Rev. Lett., 23: 1068-71(Nov. 3, 1969).

Differential cross sections for the reaction $\pi^-p \rightarrow \pi^0n$ near 180° at 4, 6, 8, and 11 GeV/c were measured. Data analysis and results are presented. (auth)

1520 UNSPLIT K*'S. Davis, Philip J.; Derenzo, Stephen E.; Flatte, Stanley M.; Garnjost, Margaret A.; Lynch, Gerald R.; Solmitz, Frank T. (Univ. of California, Berkeley). Phys. Rev. Lett., 23: 1071-4(Nov. 3, 1969).

It is shown that the $K_N(1420)$ and the $K^*(890)$ in the 12-GeV/c K^+p experiment fit poorly to the double-pole structure reported for the A_2 meson. The probability that the data agree with the double-pole hypothesis is less than 1% for the $K_N(1420)$ and completely negligible for the $K^*(890)$, although both resonances are fitted well by a Breit-Wigner shape. The mass resolution is ±7 MeV at the $K_N(1420)$ and ±5 MeV at the $K^*(890)$. (auth)

1521 PRODUCTION ANGULAR DISTRIBUTION OF XI^{*0}. Saxena, Anand B.; Singh, C. P.; Agarwal, B. K. (Allahabad Univ., India). Progr. Theor. Phys. (Kyoto), 42: 408-10(Aug. 1969).

From a rescattering square diagram the production angular distribution is calculated for Ξ^{*0} production in $K^- + p \rightarrow \Xi^{*0} + K^0$ interactions at 2.24 and 3.0 GeV/c. This is done to give a qual-

itative explanation of the backward peaking in the interaction studied. (J.F.P.)

1522 INTERFERENCE BETWEEN $K_L \rightarrow \pi^+\pi^-$ AND $K_S \rightarrow \pi^+\pi^-$ BEHIND A COPPER REGENERATOR. Faissner, H. (Technische Hochschule, Aachen); Foeth, H.; Staude, A.; Tittel, K.; Darriulat, P.; Kleinknecht, K.; Rubbia, C.; Sandweiss, J.; Ferrero, M. I.; Grosso, C. Phys. Lett., 30B: 204-8(Sept. 29, 1969).

The interference between $K_L \rightarrow \pi^+\pi^-$ and $K_S \rightarrow \pi^+\pi^-$ behind a copper regenerator was observed in a high statistics experiment. The modulus and the argument of the complex ratio $\rho(p)/\eta_{+-}$, where $\rho(p)$ is the regeneration amplitude and $\eta_{+-} = A(K_L \rightarrow \pi^+\pi^-)/A(K_S \rightarrow \pi^+\pi^-$, were measured over the momentum interval from 2.0 GeV/c to 6.0 GeV/c. The phase of η_{+-} as deduced from this measurement and from the optical model value of arg $[\rho(p)]$ is $49.3^0 \pm 6.8^0$. The $K_L - K_S$ mass difference has been found to be $\Delta m/\hbar = (0.555 \pm 0.020) \times 10^{10}$ sec^{-1}. (auth)

1523 $\pi^+n \rightarrow \eta p$: A REGGE PARAMETRIZATION OVER A LARGE ENERGY RANGE USING VENEZIANO-TYPE RESIDUE FUNCTIONS. Danburg, J. S.; Abolins, M. A.; Brower, R. C.; Dahl, O. I.; Davies, D. W.; Hoch, P. L.; Kirz, J.; Miller, D. H.; Rader, R. K. (Univ. of California, Berkeley). Phys. Lett., 30B: 270-3(Oct. 13, 1969).

A low-background sample of approximately 350 events from the reaction $\pi^+n \rightarrow \eta p$ was obtained from a study of the reaction $\pi^+d \rightarrow pp\pi^+\pi^-\pi^0$ in a bubble chamber experiment with incident pion momentum between 1.1 and 2.4 GeV/c. The η production angular distributions and the total η cross section are well fitted by a simple two-parameter Reggeized A_2-exchange model with Veneziano-type residue functions and a normal-slope A_2 trajectory. The parametrization is also compared with data from other experiments spanning the incident momentum range from near threshold to 18.2 GeV/c. Although agreement is very good for the total cross section, present data indicate that the parametrization exhibits too much shrinkage at the highest energies. (auth)

1524 DIFFERENTIAL CROSS SECTION OF THE REACTION $\pi^+ + p \rightarrow K^+ + Y^*(1385)$ AT 4.0 AND 5.05 GeV/c. Ying, S. P. (Univ. of Michigan, Ann Arbor); Akerlof, C. W.; Meyer, D. I.; Pruss, S. M.; Lales, J.; Lundy, R. A.; Rust, D. R.; Ward, C. E. W.; Yovanovich, D. D. Phys. Lett., 30B: 289-92(Oct. 13, 1969).

Approximately 1900 events were obtained in the differential cross section measurements of the reaction $\pi^+ + p \rightarrow K^+ + Y^*$ (1385). Forward peaks were found with slopes of 2.3 ± 0.3 and 2.6 ± 0.4 (GeV/c)$^{-2}$ for 4 and 5.05 GeV/c respectively. The data together with that on other decuplet production reactions give evidence of a large SU(3) violation as would be expected from the mass splitting of the strange and nonstrange exchanged particles. (auth)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstract 1150.

1525 HIGH ENERGY PHYSICS INDEX. Volume 7, No. 18, 1969. Frankfurt am Main, Zentralstelle fuer Atomkernenergie-Dokumentation, 1969. 60p.

1526 HIGH ENERGY PHYSICS INDEX. Volume 7, No. 19, 1969. Frankfurt am Main, Zentralstelle fuer Atomkernenergie-Dokumentation, 1969. 57p.

1527 HIGH ENERGY PHYSICS INDEX. Volume 7, No. 20, 1969. Frankfurt am Main, Zentralstelle fuer Atomkernenergie-Dokumentation, 1969. 55p.

1528 UNIFIED THEORY OF ELEMENTARY PARTICLES. Ryazanov, G. V. (Inst. of Theoretical Physics, Moscow). Dokl. Akad. Nauk SSSR, 186: 1306-8(June 21, 1969). (In Russian).

The possibility of constructing a logically simple and general theory of physical phenomena is presented. The basic concepts are space-time of the special relativity theory and world lines. For the law of motion a simple measure is selected in which the correlation between successive positions of a particle is minimal. The model of the universe is assumed to be a cluster of world lines of $N = 10^{80}$ particles, which are equally distributed over a sphere of radius $R = 10^{28}$ cm with invariant topological characteristics. Proofs are presented to show that the electromagnetic interaction is fundamental and irreducible. The interactions do not differ. Only the magnitude of the binding constant is of importance. It is assumed that there is a finite field mass for each particle as a result of interaction of the particle with the universe. Quantum mechanics is treated as a consequence of a variable direction of time in the microworld and the result of particle interaction with the universe. (TTT)

1529 SYMPOSIA ON THEORETICAL PHYSICS AND MATHEMATICS. VOLUME 9. Lectures Presented at the 1968 Sixth Anniversary Symposium of the Institute of Mathematical Sciences, Madras, India. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1969. 289p. $27.50. (CONF-680121).

The conference included 16 papers. Separate abstracts were prepared for nine papers. Other papers not abstracted were the zero-temperature Heisenberg ferromagnet as a field theory, photon statistics and coherence in light beams, stochastic integration and differential equations, aspects of operational research, Nevanlinna theory and gap series, uniform distribution and densities on locally compact Abelian groups, and vector spaces of analytic functions. (J.F.P.)

For abstracts of individual papers see: 1530, 1531, 1542–1544, 1600, 1629, 1630, and 1673.

1530 ON THE ALGEBRA OF L-MATRICES. Ramakrishnan, Alladi (MATSCIENCE, Madras). Symp. Theor. Phys. Math., 9: 73-8(1969).

From Symposium on Theoretical Physics and Mathematics, Madras, India. See CONF-680121.

A method of constructing higher dimensional anticommuting matrices from a primitive set of three (2×2) Pauli matrices is summarized as an algebra of L-matrices. A step by step procedure of obtaining $(2n + 1)$ anticommuting matrices is expressed through a single prescription. (J.F.P.)

1531 L-MATRICES AND PROPAGATORS WITH IMAGINARY PARAMETERS. Ramakrishnan, Alladi (MATSCIENCE, Madras). Symp. Theor. Phys. Math., 9: 79-84(1969).

From Symposium on Theoretical Physics and Mathematics, Madras, India. See CONF-680121.

L-matrices for propagators for elementary particles are discussed. Also imaginary-mass and super-light particles are considered. Fourier transforms of the resolvent and the physical interpretation are given. (J.F.P.)

1532 COMMENTS ON LOGARITHMIC MASS FORMULA. Saleem, Mohammad (Panjab Univ., Lahore). Progr. Theor. Phys. (Kyoto), 42: 418-20(Aug. 1969).

A formula was previously proposed in which the masses of elementary particles are expressed in terms of a logarithmic function of an integer. The assertion that the observed masses are nicely reproduced by this mass formula is analyzed. (J.F.P.)

1533 A NOTE ON DAUGHTER POLES AT NONVANISHING ENERGY. Arai, Masahiko (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 42: 385-93(Aug. 1969).

Equations which are satisfied by each daughter pole at any value of s are obtained for spinless particles by using the Bethe–Salpeter equation. The main assumptions are that Regge trajectories are analytic functions of λ at the physical value, where λ is a parameter which appears in the B-S equation, and that the residue of a parent Lorentz pole is analytic at $s = 0$, in addition to the usual analyticity requirements. (auth)

1534 GOOD AND BAD OPERATORS IN CURRENT ALGEBRA SUM RULES. Stern, H.; Meuldermans, R. (Univ., Louvain, Belg.). Nuovo Cim., 64A: 7-12(Nov. 1, 1969).

An ambiguity in current algebra sum rules is traced to the use of one good and one bad operator, but will exist even in the absence of Z-graphs. It is shown that from the work of Gilman and Harari, the dynamical assumptions which ensure the convergence of the dispersion integrals, resolve the ambiguity. (auth)

Electromagnetic

Refer also to abstracts 1557, 1591, 1613, and 1646.

1535 (JINR-P4-4646) OPTICS AND NUCLEAR PHYSICS. Frank, I. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1969. 16p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The dependence of the radiation of a fast particle moving in a medium on the optical properties of this medium is considered. More emphasis is placed on the transition radiation of a relativistic particle and on the scattering of light by a relativistic electron in a medium. (auth)

1536 MEASUREMENT OF THE g-FACTOR ANOMALY OF THE MUON. Henry, G. R. (Stanford Univ., Calif.); Schrank, G.; Swanson, R. A. Nuovo Cim., 63A: 995-1000(Oct. 21, 1969).

A measurement of $(g-2)$ for the free, positive muon has been carried out, yielding $(g/2-1) = 0.001,060 \pm 0.000,067$, in substantial agreement with theory and independent experiments. The method may be useful in future work. (auth)

1537 THE N*(1400) AND THE n-p MASS DIFFERENCE. Lyth, D. H. (Univ. of Lancaster, Eng.). Nuovo Cim., 63A: 931-47(Oct. 21, 1969).

The assumption of N*(1400) dominance of the nucleon propagator is formulated. The direct N-N* coupling constant is defined and estimated numerically via "nucleonic" form factors and unitarity rather than by pure field theory. If N* dominance is assumed to be valid asymptotically, finite (therefore presumably ridiculous) values are implied for the nucleon renormalization constant Z^{-1} and bare mass M_0 ($Z^{-1} \simeq 2$, $M_0 \simeq 1500$ MeV), and also a formula is obtained giving the n-p mass-difference in terms of the N*(1400) mass splitting and the splittings of the πNN and πNN^* coupling constants. Other approaches to the n-p mass-difference problem are reviewed, points of importance being: (i) the feedback mechanism of Fried and Truong is equivalent in principle to the present approach using propagator asymptotics, (ii) however these and several other authors have erroneously assumed that the "pure electromagnetic" Feynman-graph contribution (which gives the wrong sign) is equal to a certain dispersion integral, (iii) many approaches exist (present approach, Cottingham, Zachariasen–Suzuki, Pagels, bootstraps) which are not manifestly equivalent. (auth)

1538 POSITIVE-PION PHOTOPRODUCTION WITH COHERENT BREMSSTRAHLUNG. II. ANALYSIS OF THE RESULTS. Grilli, M. (CNEN, Frascati, Italy); Spillantini, P.; Valente, V.; Nigro, M.; Schiavuta, E. Nuovo Cim., 63A: 1188-98(Oct. 21, 1969).

The results of a phenomenological analysis of the data of π^+ photoproduction with coherent bremsstrahlung are reported. By means of a polynomial analysis of the cross section some multipole amplitudes are evaluated and critically discussed. A comparison between π^+ and π^0 photoproduction is carried out. The validity of the procedure followed is discussed. (auth)

1539 MODEL OF THE ELECTRON. Liebowitz, B. Nuovo Cim., 63A: 1235-46(Oct. 21, 1969).

It is universally believed that Planck's constant h is entirely beyond the purview of classical conceptions. It is shown that this belief is not justified, namely by constructing a model of the electron based wholly on spinning and precessing classical electric and magnetic fields; the main properties of the model, so far as they are considered herein, are (1) its calculated angular momentum is $\hbar/2$ within a few percent; (2) it has a magnetic moment of one Bohr magneton plus a small "anomalous" magnetic moment; and (3) it endows the zitterbewegung of the Dirac theory with dynamical reality. Some further consequences of the model are briefly described in a recent paper. (auth)

1540 ABSORPTION MODEL AND U(6,6) FOR PHOTOPRODUCTION PROCESSES. Fincham, D. G.; Hunt, A. P.; Migneron, J. H. R.; Moriarty, K. (Imperial Coll. of Science and Tech., London). Nucl. Phys., B13: 161-81(1969).

The absorption model is applied to photoproduction processes at intermediate energies assuming vector dominance. U(6,6) is used to uniquely determine the couplings of the exchanged pseudoscalar and vector mesons. (auth)

1541 REAL PARTS OF VECTOR-MESON SCATTERING AMPLITUDES. Swartz, J.; Talman, R. (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett., 23: 1078-80(Nov. 3, 1969).

The determination of the ρ-photon coupling constant by photoproduction from complex nuclei can be brought into agreement with other determinations by invoking a real part of the ρ-nucleon scattering amplitude, thus determining the magnitude of the real part. A similar analysis with φ mesons is possible with available data. (auth)

1542 IMPLICATIONS OF CURRENT ALGEBRA FOR η DECAY. A SUMMARY. Ramachandran, R.; Kumar, Aditya (Tata Inst. of Fundamental Research, Bombay). Symp. Theor. Phys. Math., 9: 33-42(1969).

From Symposium on Theoretical Physics and Mathematics, Madras, India. See CONF-680121.

Various current algebra approaches for η decays are reviewed and an extrapolation procedure is suggested which it is believed best explains this process. The scalar density model, the electromagnetic Hamiltonian, quadratic terms in the matrix element, the effective Lagrangian, and final-state interactions are discussed. (J.F.P.)

1543 ELECTROMAGNETIC INTERACTION OF PARTICLES WITH SPIN. Good, R. H. Jr. (Ames Lab., Iowa). Symp. Theor. Phys. Math., 9: 59-71(1969).

From Symposium on Theoretical Physics and Mathematics, Madras, India. See CONF-680121.

A review is given of a relativistic theory for a particle or antiparticle of definite nonzero mass and spin in an external electromagnetic field. The effects of anomalous electric and magnetic moments are also considered. Covariantly defined matrices for spin-1, the spin-1 wave equation, and spin-$3/2$ and higher wave equations are discussed. (J.F.P.)

1544 HIERARCHY OF IDEMPOTENT MATRICES. Ramakrishnan, Alladi; Vasudevan, R. (MATSCIENCE, Madras). Symp. Theor. Phys. Math., 9: 85-8(1969).

From Symposium on Theoretical Physics and Mathematics, Madras, India. See CONF-680121.

The A matrix is discussed. It is noted that higher-dimensional A-matrices are obtained by embedding an L-matrix and not the A-matrix. The direct relation with the polarization states of the photon and implications that the particle and antiparticle of the photon are the same are mentioned. The relativistic eigenstates of an elementary particle in the case of A_5 which represents a particle of spin $1/2$ are pointed out. (J.F.P.)

1545 η-RADIATIVE DECAYS IN HARD MESON APPROACH. Caprini, I.; Micu, L. (Inst. for Atomic Physics, Bucharest). Progr. Theor. Phys. (Kyoto), 42: 339-45(Aug. 1969).

Using a hard meson analysis of the PVV vertex and a pole approximation for the three particle decay amplitude the ratios: $\Gamma(\eta \to 2\gamma)/\Gamma(\pi^0 \to 2\gamma)$, $\Gamma(\eta \to \pi^0 2\gamma)/[\Gamma(\pi^0 \to 2\gamma)]^2$ are evaluated. A rather good agreement with the experimental data is obtained with a mixing angle of about $-13°$ between the pseudoscalar unitary octet and singlet. A discussion of the results is given. (auth)

1546 BARYON ELECTROMAGNETIC MASS DIFFERENCES. Uchiyama-Campbell, F.; Silbar, R. R. (Los Alamos Scientific Lab., New Mex.). Progr. Theor. Phys. (Kyoto), 42: 431-2 (Aug. 1969).

An attempt is made to calculate the proton–neutron electromagnetic mass difference and the mass difference $(\Sigma^+ + \Sigma^- - 2\Sigma^0)$ in a model in which an SU(3) symmetric, gauge invariant Lagrangian is assumed for baryons and mesons. This model has great simplicity, the only parameter being the mass of the vector meson mediating electromagnetism. The way the electromagnetic interactions are introduced allows one to avoid putting experimental information into the form factors. The nontadpole contributions to the calculated baryon electromagnetic mass difference are finite. (J.F.P.)

1547 REGULARIZATION OF INTEGRALS WITH COULOMB-TYPE SINGULARITIES. Chew, H. (Clarkson Coll. of Tech., Potsdam, N. Y.). Nuovo Cim., 63B: 565-8(Oct. 11, 1969).

A method for regularizing integrals involving Coulomb amplitudes is described. It is capable of recovering the known partial-wave amplitudes from the full nonrelativistic Coulomb scattering amplitude, up to a term independent of l. The latter term is uniquely determined by the unitarity condition. (auth)

1548 PHOTOPRODUCTION OF THE $\Delta(1238)$ ISOBAR AT PHOTON ENERGIES BELOW 1 GeV. Dogyust, I. V.; Naisteter, S. I. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh., 14: 235-9(Feb. 1969). (In Russian).

Photoproduction of the $\Delta(1236)$ isobar at the photon energies below 1 GeV is discussed within the framework of the model taking into account the single pion diagram and the mechanism of N*(1518) exchange in the S-channel. The differential transversal cross section, the total cross section for the $\Delta(1238)$ isobar photoproduction by unpolarized photons and asymmetry in the case of polarized photons are calculated within the given model. The obtained calculated results are compared with the experimental data. (auth)

1549 REGGE POLE MODEL WITH THE DIFFRACTIVE CORRECTION. I. THE CHARGED PION PHOTOPRODUCTION. Biyajima, Minoru; Sakai, Sunao; Watanabe, Tsunetoshi (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto), 42: 282-91 (Aug. 1969).

The diffractive correction model using the evasive Regge amplitude is applied to the charged pion photoproduction. In this model the π^+ differential cross section, the π^-/π^+ ratio $[(d\sigma/dt)(\gamma n \to \pi^- p)/(d\sigma/dt)(\gamma p \to \pi^+ n)]$ and the cross section for the π^+ production with polarized photon are calculated. In the neighborhood of forward direction, the results fit experiment quite well. (auth)

1550 U-SPIN CONSERVATION TESTS FOR ELECTROMAGNETIC INTERACTIONS USING COLLIDING BEAMS. Bergmann, E. E. (Princeton Univ., N. J.). Nuovo Cim., 64A: 108-10(Nov. 1, 1969).

Methods are outlined for general U-spin predictions of hadron production in colliding lepton-antilepton beam experiments. Shmuskevich's principle and G_U-parity are employed. (auth)

1551 CONSERVATION SUM RULES. Morrison, L. K. (Brandeis Univ., Waltham, Mass.); Nussinov, S. Nuovo Cim., 64A: 212-17(Nov. 1, 1969).

Sum rules which follow in the framework of Sugawara's model from the conservation of the momentum tensor are derived. (auth)

1552 THEORY OF ρ-ω INTERFERENCE IN $\pi^+\pi^-$ PRODUCTION. Goldhaber, A. S. (State Univ. of New York, Stony Brook); Fox, G. C.; Quigg, C. Phys. Lett., 30B: 249-53(Oct. 13, 1969).

The Coleman-Glashow model for ρ-ω mass mixing permits unambiguous analysis of recent $\pi^+\pi^-$ production data. Production phase predictions of a Regge model with exchange degenerate trajectories are confirmed. The anomalous rho width observed in colliding beam reactions is explained. (auth)

1553 PERIPHERAL MODEL PREDICTIONS FOR π^0 AND η^0 PHOTOPRODUCTION. Dar, A. (Deutsches Elektronen-Synchrotron, Hamburg. Technion-Israel Inst. of Tech., Haifa); Watts, T. L.; Weisskopf, V. F. Phys. Lett., 30B: 264-9(Oct. 13, 1969).

Cross sections for photoproduction of π^0 and η^0 from nucleons with unpolarized and polarized photon beams were calculated using a new peripheral model for high energy exchange reactions. The predictions are in good agreement with available data from CEA, DESY and SLAC on photoproduction from protons. Predictions for π^0 photoproduction from neutrons are also presented. (auth)

Weak

Refer also to abstract 1648.

1554 (JINR-P2-4621) ISOTOPIC AMPLITUDES AND PHASE-SHIFTS IN THE PROCESSES WITH THE PRODUCTION OF A FEW PARTICLES BELONGING TO ONE ISOTOPIC MULTIPLET. Dumbrais, O. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1969. 7p. (In Russian). Dep. CFSTI (U. S. Sales Only).

It is pointed out that in the reactions (decays) with the production of a few particles belonging to one isotopic multiplet there exist additional expressions for isotopic amplitudes and phase-shifts by means of cross sections (probabilities). Some examples are presented. (auth)

1555 RADIATIVE CORRECTIONS TO MUON DECAY. Matsson, Leif (Inst. of Theoretical Physics, Goeteborg). Nucl. Phys., B12: 647-68(1969).

A brief historical outline is given of the various methods used for treating radiative corrections to μ-decay. General results of a method developed by Kibble are applied to $\mu^- \to e + \nu_\mu + \bar{\nu}_e$ decay, using the perturbation expansion for hard photons. The question of how to tie together the particle decay rate with those of the soft and hard photons is considered. The calculation is performed in the V-A theory for unpolarized particles. (L.B.S.)

1556 LEPTONIC DECAYS OF POLARIZED BARYONS. Linke, Volkard (Univ., Marburg, Ger.). Nucl. Phys., B12: 669-93(1969).

For leptonic transitions between polarized spin-$\frac{1}{2}$ baryons formulae are derived, which express the various assymmetry coefficients in the angular distribution of the decay products in terms of the form factors of the weak baryonic current. (auth)

1557 SOME COMMENTS ON THE LOVELACE–VENEZIANO MODEL OF K AND η THREE PION DECAYS. Sutherland, D. G. (Univ. of Glasgow). Nucl. Phys., B13: 45-52(1969).

The relation of the Lovelace–Veneziano model for K and $\eta \to 3\pi$ to current algebra treatments is discussed. Some ambiguities related to other diagrams expected by SU(3) are discussed and the problem of the rates is considered with some surprising results. (auth)

1558 LEPTON NONCONSERVATION AND THE EARLY UNIVERSE. Oster, Ludwig (Univ. of Colorado, Boulder). Phys. Rev. Lett., 23: 987-8(Oct. 27, 1969).

It is pointed out that the existence of a neutrinoless β-decay process would provide a basis for the customary assumption that the number of neutrinos and antineutrinos is equal in the universe. (auth)

1559 LEPTON DECAY OF Σ HYPERONS AND THE CABIBBO THEORY. Schneider, H. (Univ., Heidelberg). Fortschr. Phys., 17: 393-461(1969). (In German).

A review is given of the present experimental state of the lepton decay of baryons, especially the Σ hyperon. On the basis of the charge reflected $\Delta S = 0$ decays $\Sigma^+ \to \Lambda e^+ \nu$, the weak interaction can be tested for time reversal invariance, for currents of the second type, and for vector current conservation. The experimental results agree with the hypothesis of the conservation of the vector current and neither a violation of the time reversal invariance nor the presence of currents of the second type was observed. According to the rate of the neutron beta decay, the rates of the $\Delta S = \Delta Q = 1$ baryon decays $\Sigma^- \to ne\nu$ and $\Sigma^- \to n\mu\nu$ were determined with an accuracy of 13% or 18% at best. The decays $\Sigma^+ \to ne^+\nu$ and $\Sigma^+ \to n\mu^+\nu$ permit a testing of the selection rule $\Delta S = \Delta Q$. Out of 270,000 or 180,000 effectively studied decays $\Sigma^+ \to n\pi^+$, one or two possible lepton events were found. Because of the rareness of these events their assignment as rare configurations of other processes can not be statistically excluded. An upper limit of 0.02 was found for the ratio of the intensities $\Delta S = -\Delta Q$ and $\Delta S = +\Delta Q$. The total experimental results of all lepton baryon decays are compatible within the measurement accuracy with a theory proposed by Cabibbo. This theory permits a universal description of all lepton reactions both with $\Delta S = 0$ and with $\Delta S = 1$. The amplitudes $\Delta S = 1$ and $\Delta S = 0$ were established by two angles θ_V and θ_A for vector or axial vector current. An equality of θ_V and θ_A can not be established by the experimental results. The mixing parameter α, which describes the contribution of the D and F coupling in the axial vector current, is in agreement with the theoretical α values for the baryon–pseudoscalar meson–baryon strong coupling. (tr-auth)

1560 WEAK AND ELECTROMAGNETIC MASS DIFFERENCES AND THE PRINCIPLE OF ZERO. Takasu, Masashi (Meijo Univ., Japan). Progr. Theor. Phys. (Kyoto), 42: 422-3(Aug. 1969).

It is shown that when the quadratic divergences in the weak mass differences are made finite, the logarithmic ones in the weak and electromagnetic mass differences cannot be made with the charged weak currents and bosons only, thus neutral ones seem to be needed. After the introduction of the neutral ones, the principle of zero holds and determines a set of natural values of quantities. (J.F.P.)

1561 COMPOSITE MODEL OF MESONS AND f_-/f_+ RATIO IN K_{l3} DECAY. Kaneko, Takao (Meijo Univ., Nagoya, Japan). Progr. Theor. Phys. (Kyoto), 42: 428-30(Aug. 1969).

The value of the ratio f_-/f_+ of form factors for three-body leptonic kaon decay is estimated. For this purpose the composite model and a previously derived expression are used. (J.F.P.)

1562 F_π/F_K RATIO AND πK SCATTERING AMPLITUDE OF THE VENEZIANO TYPE. Oyanagi, Yoshio; Tokuda, Naoki (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 42: 430-1(Aug. 1969).

The ratio of decay constants for $\pi \to \mu + \nu$ and $K \to \mu + \nu$ decays is obtained from a comparison of the soft-pion and soft-kaon limits of the π + K Veneziano-type amplitude. The good agreement with the experimental values is further evidence of the validity of Veneziano-type amplitudes extrapolated off the mass shell. (J.F.P.)

1563 EFFECTS OF $\Delta S = -\Delta Q$ AMPLITUDES ON μ POLARIZATION IN $K_L \to \pi\mu\nu$ DECAYS. Field, J. H. (Rutherford High-Energy Lab., Chilton, Eng.). Nuovo Cim., 64A: 184-8(Nov. 1, 1969).

Expressions are given for the complex form factor ratio ξ, appearing in the matrix element for $K_L \to \pi\mu\nu$ decay, in terms of a $\Delta S = +\Delta Q$ amplitude ξ', and two $\Delta S = -\Delta Q$ amplitudes x_+ and x_-. A method of measuring the real and imaginary parts of all three amplitudes by combining experimental data on μ polarization in $K_L \to \pi\mu\nu$ decays with rate measurements of the $\pi\mu\nu$, $\pi e\nu$ decays in the K_S, K_L interference region, is discussed. (auth)

1564 $J^P = \frac{1}{2}^\pm$ BARYON RESONANCES AND NONLEPTONIC HYPERON DECAYS. Trofimenkoff, N. N. (Australian National Univ., Canberra). Ann. Phys. (N. Y.), 55: 146-65(Oct. 15, 1969).

The relative importance of $J^P = \frac{1}{2}^\pm$ baryon resonances in nonleptonic hyperon decays is investigated within a dispersion relation formulation of the current algebra-PCAC method with a view to establishing which resonances can be neglected. The dispersion relation formulation is reviewed, equal-time commutator and octet baryon pole terms are calculated, and then pion-octet baryon intermediate states are included in the calculation of the imaginary parts of the amplitudes for the dispersion relations. The imaginary parts of the amplitudes then involve pion-octet baryon scattering amplitudes for which a resonance approximation is used and weak nonleptonic amplitudes which are approximated by the equal-time commutator and octet baryon pole terms. An evaluation of the resulting dispersion integrals shows that it is safe to neglect

resonances with $J^P = \frac{1}{2}^+ (J^P = \frac{1}{2}^-)$ in S-wave (P-wave) decays and, also, that the P-wave amplitude of $\Sigma^+ \to n + \pi^+$ may be substantially enhanced by the resonance N'(1470). (auth)

Strong (General)

Refer also to abstract 1637.

1565 ARE REGGE TRAJECTORIES STRAIGHT LINES? Kelemen, P. J.; Lee, K. Y.; Piel, W. F. Jr. (Indiana Univ., Bloomington). Phys. Rev. Lett., 23: 998-1000(Oct. 27, 1969).

For several Regge trajectories of elementary particles, formula fits to the experimental masses are exhibited. It is found that it may be premature to conclude that even the existing trajectories form straight lines when the squares of the particle masses are plotted against the particle spins. (auth)

1566 ON THE TWO-BARYON SECTOR OF SOLUBLE MODELS WITH INDEFINITE METRIC. II. Nachtmann, O. (CERN, Geneva). Nucl. Phys., B13: 23-6(1969).

A soluble model with internal symmetry group is shown to have an unphysical state on the real energy axes. If one can freely add further interactions, this state can be made to go to the complex plane. (auth)

1567 ON THE TWO-BARYON SECTOR OF SOLUBLE MODELS WITH INDEFINITE METRIC. I. Nachtmann, O. (CERN, Geneva). Nucl. Phys., B13: 9-22(1969).

Systems containing two unphysical particles with complex energies are studied. It is shown that states which lie on the real axes, if one has no interaction between the two unphysical particles, go to the complex plane in presence of interaction. (auth)

1568 SELF-CONSISTENT OFF-MASS-SHELL AMPLITUDE DERIVED FROM THE GENERALIZED VENEZIANO MODEL. Ohba, Ichiro (Waseda Univ., Tokyo) Progr. Theor. Phys. (Kyoto), 42: 432-5(Aug. 1969).

An ambiguity in the formulation, with the help of a spurion having the vacuum quantum numbers, of the off-mass-shell amplitudes for an extension of the Veneziano model to the N-particle amplitude satisfying the duality condition is pointed out. Also a possible prescription to formulate the off-mass-shell amplitude from the generalized Veneziano model is proposed. (J.F.P.)

Strong (Baryon No. = 0)

Refer also to abstracts 1648 and 1773.

1569 VENEZIANO AMPLITUDE WITH COMPLEX TRAJECTORIES. Paciello, M. L.; Sertorio, L.; Taglienti, B. (Univ., Rome). Nuovo Cim., 63A: 1026-34(Oct. 21, 1969).

A modification of the Veneziano-model amplitude is discussed, in the case of the $\pi^+\pi^- \to \pi^+\pi^-$ reaction, which contain complex trajectories and consequently no infinities in the physical region. Although the modification is simple the consequences are relevant. It follows in fact that ancestors exist; the relevance of this is discussed in some detail. It follows also in this model, that even in a spinless case the Regge behavior does not belong to the full amplitude but instead to a factor of it. (auth)

1570 WHAT IS THE NATURE OF THE $I^G J^P = 0^+0^+$ $K\overline{K}$ THRESHOLD ENHANCEMENT? Margulies, S. (Univ. of Illinois, Chicago); McLeod, D. W.; Phelan, J. J. Nuovo Cim., 63A: 1124-30(Oct. 21, 1969).

The $I^G J^P = 0^+0^+$ threshold enhancement in the $K\overline{K}$ system has been variously interpreted in terms of a complex scattering length, and in terms of a resonant state called the S*. Despite many experiments, it is presently impossible to objectively decide between these two hypotheses. The poor consistency of the data supporting the resonance interpretation is demonstrated by examining the results of the resonance parametrizations. The weighted average from all such experiments is $M_0 = (1062 \pm 5)$ MeV/c^2, $\Gamma_0 = (97 \pm 11)$ MeV/c^2, with χ^2 probabilities of 1.4 and 0.1%, respectively. Thus, it appears likely that either the quoted errors are considerably underestimated or that the results of several experiments are incorrect, or perhaps both. In addition, the possible existence of energy-dependent interference effects cannot be excluded. (auth)

1571 $\rho \to 4\pi$ DECAY FROM CURRENT ALGEBRA. Ellis, J.; Renner, B. (Cambridge Univ., Eng.). Nucl. Phys., B13: 108-12(1969).

With a view to possible tests in colliding beam experiments, an estimate is obtained for $\Gamma(\rho^0 \to \pi^+\pi^+\pi^-\pi^-)/\Gamma(\rho^0 \to \pi^+\pi^-)$ as a low-energy theorem. Current algebra enters in determining the $(\pi\pi)$ scattering amplitudes. (auth)

1572 VECTOR-PSEUDOSCALAR SCATTERING AND THE VENEZIANO MODEL. Kosterlitz, J. M. (Oxford Univ.). Nucl. Phys., B13: 129-38(1969).

An attempt is made to construct a representation in a Veneziano type model of the amplitude for vector-pseudoscalar scattering, taking into account the constraints imposed by parity and crossing. (auth)

1573 BROKEN CHIRAL SYMMETRY AND THE VENEZIANO MODEL. Cronin, Jeremiah A.; Kang, Kyungsik (Brown Univ., Providence). Phys. Rev. Lett., 23: 1004-7(Oct. 27, 1969).

Chiral-symmetry breaking within the $K\pi$ system is investigated when a Veneziano model is assumed for various off-mass-shell extrapolations. Expressions are derived for the matrix elements of σ terms and the divergence of the strangeness-changing current and discuss the implications to chiral-symmetry-breaking interactions. Application of our results to the K_{l3} form factors gives $f_K/f_\pi f_+(0) = 1.35$ and the relation $(f_K/f_\pi)^2 = \cos[\alpha'_{K^*}(0)(\mu_K^2 - \mu_\pi^2)]$. (auth)

1574 CURRENT DIVERGENCE COMMUTATORS AND SCALAR MESONS. Ellis, John (Cambridge Univ., Eng.). Nucl. Phys., B13: 153-60(1969).

Assuming that current divergences transform under the representation $(3,3^*) + (3^*,3)$ of $SU_3 \times SU_3$, the relative strengths of SU_3 and chiral symmetry breaking terms in the hadron energy density are estimated assuming π-meson PCAC alone. Secondly it is found that no effects which depend on scalar mesons or on the inequality of f_K and f_π can be deduced if π-, K-, and η-meson PCAC are assumed. However, using only π-meson PCAC and the inequality of f_K and f_π a mass $\geq$1000 MeV is favored for the scalar $(K\pi)$ resonance κ. (auth)

1575 RELATIVISTIC WAVE EQUATION AND LINEAR MESON TRAJECTORIES. Takabayasi, Takehiko (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto), 42: 423-5(Aug. 1969).

An infinite-component wave equation associated with a relativistic dynamical group is presented, which corresponds to linear meson trajectories similar to those implied by the Veneziano model. This may suggest a structural and group theoretic structure for the latter. A relativistic oscillator model described by a bilocal wave function and two variant models are also discussed. (J.F.P.)

1576 ON THE $\phi - \pi$ DECAY MODE OF THE B MESON. Hasebe, Katsuya (Aichi Univ., Japan). Progr. Theor. Phys. (Kyoto), 42: 410-11(Aug. 1969).

The reason for the lack of B(1220) decay in the $\phi + \pi$ mode is discussed. It is assumed that the spin-parity of this meson is 1^+, though 2^+, 3^- ... are still possible. (J.F.P.)

1577 DUALITY DIAGRAMS AND SUPERMULTIPLETS. Delbourgo, R.; Rotelli, P. (Imperial Coll. of Science and Tech., London). Phys. Lett., 30B: 192-5(Sept. 29, 1969).

Using the relativistically covariant multispinor formalism, a unique prescription is offered for calculating any legal duality diagram and the method is applied to meson-meson scattering. The recipe incorporates many of the attractive features of Veneziano models and supermultiplet schemes. (auth)

1578 MASS EXTRAPOLATION USING DUAL AMPLITUDES. Rubinstein, H. R. (Bohr Inst., Copenhagen. Weizmann Inst., Rehovoth, Israel); Squires, E. J.; Chaichian, M. Phys. Lett., 30B: 189-91(Sept. 29, 1969).

A method of mass extrapolation based on the use of Veneziano forms of scattering amplitudes is discussed for the $\bar{p}n \to \pi^-\pi^-\pi^+$ threshold interaction. (L.B.S.)

1579 POLE DOMINANCE IN THE $\omega\rho\pi$-VERTEX. Farkas, I.; Pocsik, G. (Roland Eoetvoes Univ., Budapest). Nuovo Cim., 64A: 1-6(Nov. 1, 1969).

The $\omega\rho\pi$-vertex is discussed on the basis of the current algebra and c-number Schwinger terms. A simple relation is derived which shows that (1) the invariant function of the $\omega\rho\pi$-vertex tends to zero for large values of $(p_\pi - p_\omega)^2$; (2) the ρ-pole dominance gives rise to a fairly good fit and (3) the fit of the once-integrated current commutator turns out to be worse than that of the corresponding density algebra. (auth)

1580 $A_1 \to 3\pi$ DECAY. Dass, G. V.; Papageorgiou, S. (CERN, Geneva). Nuovo Cim., 64A: 36-49(Nov. 1, 1969).

The coupling of the A_1 to a three-pion system is studied through the analysis of some simple two-body amplitudes where the A_1 appears as an either external or internal particle. The $A_1 \to 3\pi$ decay amplitudes to a pion and a P-wave or S-wave $\pi\pi$ system are related in the Veneziano model. The relevant ambiguities in the construction of dual amplitudes involving unnatural-parity trajec-

tories are discussed and some results on the strengths of the decays involving the two $\pi\pi$ systems are presented. Further experimental information of the four-pion decay of the f^0 would help to determine the strength of the A_1 decay involving the spinless dipion system. (auth)

1581 I = 0, S-WAVE $\pi\pi \rightarrow K\bar{K}$ INTERACTION NEAR THRESHOLD. Hoang, T. F. (Argonne National Lab., Ill.). Nuovo Cim., 64A: 55-74(Nov. 1, 1969).

An analysis of the I = 0, S-wave $\pi\pi \rightarrow K\bar{K}$ interaction near threshold was carried out using a complex effective-range model. The absolute cross sections of $\pi\pi \rightarrow K\bar{K}$ are extracted from CERN and Argonne experiments on $\pi^- + p \rightarrow K_1 + K_1 + n$. Least-squares fits to $\sigma_{\pi\pi \rightarrow K\bar{K}}$ yield two solutions of comparable χ^2. Solution I leads to a bound state of ~0.957 GeV with a $\pi\pi$ decay width of ~8 MeV. Solution II gives rise to a virtual state with a complex mass: (0.929—i0.090) GeV. Argand diagrams of both solutions do not exhibit the characteristics of a resonance. The scattering length considered as a special case of the present method was also re-evaluated: the real and imaginary parts are found to be $|a| = (0.72 \pm 0.15)$ and $b = (0.085 \pm 0.011)$ fm, respectively. Comparison with Argand diagrams of solutions I and II indicates: $a < 0$. A discussion on other related effects is presented. (auth)

1582 ANALYSIS OF PERIPHERAL PION PRODUCTION WITH A UNITARIZED $\pi\pi$ VENEZIANO FORMULA. Wagner, F. (CERN, Geneva). Nuovo Cim., 64A: 189-205(Nov. 1, 1969).

From a unitarized Veneziano formula, predictions are made for the $\pi\pi$ scattering amplitude up to 1 GeV, and also its off-shell Δ^2 dependence which differs especially in the s-waves from previous peripheral models. The results are in good agreement with pion production experiments. (auth)

1583 APPLICATION OF THE UNITARIZED VENEZIANO MODEL TO THE VERY-LOW-ENERGY PION PRODUCTION. Roberts, R. G.; Wagner, F. (CERN, Geneva). Nuovo Cim., 64A: 206-11(Nov. 1, 1969).

Lovelace's unitarized form of the $\pi\pi$ Veneziano amplitude predicts the behavior of the S-wave I = 0 interaction. This is shown to give satisfactory agreement with the data for low-energy $\pi N \rightarrow \pi\pi N$. (auth)

1584 CONSTRAINTS ON $\pi\pi$ PARTIAL WAVES FROM POSITIVITY AND ANALYTICITY. Yndurain, F. J. (CERN, Geneva). Nuovo Cim., 64A: 225-42(Nov. 1, 1969).

The constraints on the partial waves for $\pi^0\pi^0$ or $\pi\pi$ in the isospin-zero channel, that follow from analyticity and positivity are considered. It is shown that, if these two requirements are met, then a set of inequalities on the partial waves with $l \geq 2$ and energy below threshold must be satisfied. The converse is also proved showing that, if these constraints are fulfilled, then an analytic scattering amplitude with positive absorptive part can be constructed. The practical importance of these conditions is discussed showing that, for example, they imply the inequalities (pion mass = 1) $a_{l+2} < (1/16)[(l + 2)(l + 1)/(l + \frac{3}{2})(l + \frac{3}{2})]\, a_l$; here a_l are the scattering lengths, $a_l = \lim f_l(s)/q^{2l}$. Furthermore, these inequalities (which had essentially been also found by Martin) are saturated very accurately when $l \geq 4$. The relevance of our analysis for models of $\pi\pi$ scattering is discussed. (auth)

1585 VENEZIANO MODEL FOR MESON SYSTEMS. Fayyazuddin; Riazuddin (Univ. of Islamabad, Rawalpindi, Pakistan). Ann Phys. (N. Y.), 55: 131-45(Oct. 15, 1969).

The Veneziano model for meson systems involving axial-vector vector, pseudoscalar and scalar particles is investigated. Weinberg mass relations for the axial-vector mesons are derived. The connection between this model and the chiral symmetry is discussed. Some relations between the decay parameters of various mesons are derived. Using the field current identity for the hypercharge changing weak axial-vector current, complete expressions are given for two of the form factors F_1 and F_2 in K_{l4} in terms of the Veneziano amplitude for the process $\pi K \rightarrow \pi K_A$. It is shown that the constraints of the current algebra in the soft pion limit are satisfied by these expressions. (auth)

1586 DETAILED DYNAMICS OF NARROW RESONANCE MODELS FOR $\pi\pi$ SCATTERING. Sivers, Dennis; Yellin, Joel (Univ. of California, Berkeley). Ann. Phys. (N. Y.), 55: 107-30 (Oct. 15, 1969).

The dynamical behavior of narrow resonance models for $\pi\pi$ scattering is discussed in the framework of what is called atonous duality, by which is meant that the pole locations and residues in a particular channel completely specify the narrow resonance amplitude as a Mittag–Leffler expansion containing no entire functions. The following assumptions are made: (i) Crossing symmetry, isospin conservation and Bose statistics hold. (ii) The only singularities of the amplitude are simple poles at locations defined by $a + b\xi(\equiv\alpha(\xi)) = 0, 1, 2, \ldots$ where ξ is a Mandelstam variable. (iii) There are no I = 2 poles. (iv) The pole at $s = \xi$ has a residue which is a polynomial in t of order $\leq\alpha(\xi)$. (v) Atonous duality holds. (vi) All partial widths are positive. Under these assumptions it is found that the I = 1 amplitude $A_1^1(v,t)$ has Regge behavior for $v \rightarrow \infty$ at fixed t, while $A_2^1(v,t)$ has pure fixed pole behavior. There are no Regge cuts. Furthermore, it is found impossible to formulate partial wave dispersion relations for these models. As an example of such a model the one term Veneziano ansatz is discussed for $\pi\pi$ scattering. (auth)

Strong (Baryon No. = 1)

Refer also to abstracts 1552, 1570, 1582, 1645, 1668, and 1673.

1587 (JINR-P1-4668) ANALYSIS OF THE SPIRAL AND SPIN AMPLITUDES IN THE REACTION $\pi^+p \rightarrow N^{*++}\rho^0$. Angelov, N.; Gramenitskii, I. M.; Kanazirski, Kh.; (and others) Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1969. 10p. (In Russian). Dep. CFSTI (US. Sales Only).

An analysis of the angular distributions of the resonance decay products was made with the aid of the helicity amplitudes in reaction $\pi^+p \rightarrow N^{*++}\rho^0$ at 2.34 GeV c. It is shown that at small angles of the resonance production θ, only one amplitude $R_+ = \langle 1/2|R|1/2\rangle$ makes the main contribution to the process considered. (auth)

1588 PRACTICAL FORMULATION OF THE ISOBAR MODEL. Chavanon, P. (College de France, Paris); Deler, B.; Smadja, G.; Valladas, G. Nuovo Cim., 63A: 1035-52(Oct. 21, 1969).

In the framework of the isobar model and starting from the results of a preceding paper expressions for the differential cross section are developed and it is shown how some properties of amplitudes and cross section can be applied to the analysis of experimental data. (auth)

1589 DEGENERACY OF BARYON TRAJECTORIES. Namyslowski, J. (Univ. of Warsaw); Swiecki, M. Nuovo Cim., 63A: 1223-8(Oct. 21, 1969).

Duality arguments and the Veneziano model are applied to the pion–baryon system to show degeneracy of baryon trajectories. There are found two pairs of degenerate trajectories of opposite signatures and parities $O_1(1/2^+ \ldots)$ $O_2(3/2^- \ldots)$, and $D(3/2^+ \ldots)$ $O_3(5/2^- \ldots)$. Masses of resonances obtained from the Veneziano type conditions on trajectories are compared with masses found from PCAC applied to the Veneziano model. (auth)

1590 CONTINUOUS-MOMENT SUM RULES AND REGGE PARAMETERS. Mohapatra, R. N. (Univ. of Richester, N. Y.). Nuovo Cim., 63A: 948-60(Oct. 21, 1969).

A new form of continuous-moment sum rules is suggested and applied to determine the P, P′ and ρ Regge residues in case of πK and KN scattering. The values are improved over previous determinations. The consistency of the sum rules demands a unique high-energy behavior of the elastic widths. This also throws some light on the origin of the Pomeranchukon. (auth)

1591 MASS DEPENDENCE OF SLOPES IN MULTIPARTICLE PRODUCTION. Trefil, J. S. (Univ. of Illinois, Urbana). Nuovo Cim., 63A: 961-8(Oct. 21, 1969).

The multiple-scattering theory is extended to investigate multiparticle production from complex targets. It is found that the slopes for resonant and nonresonant multiparticle production from protons (treated as composite systems) are very nearly equal, in agreement with experimental findings, and predictions about possible variations of the slopes as a function of mass are made. (auth)

1592 KN SCATTERING IN THE VENEZIANO MODEL. Inami, T. (Tokyo Univ.). Nuovo Cim., 63A: 987-94(Oct. 21, 1969).

The Veneziano model is applied to KN and $\bar{K}N$ scatterings. Residue parameters of the amplitudes are determined by using the high-energy behavior of KN and $\bar{K}N$ total cross sections together with the requirement that some low-energy Y* poles disappear. Excellent agreements with that data on $\bar{K}N$ charge exchange scattering KN backward scattering, and KN scattering lengths are obtained, while results on the elastic widths of Y*-resonances are less satisfactory. (auth)

1593 ABSORPTIVE REGGE MODEL AND FEATURES OF πN SCATTERING AT HIGH ENERGY. White, J. N. J. (Univ. of Glasgow). Nucl. Phys., B13: 139-52(1969).

The absorptive Regge cut associated with ρ exchange is calculated in detail as a function of the ρ, P and P′ Regge poles in the Fourier–Bessel representation. The ρ "chooses nonsense" at $\alpha_\rho = 0$ and has no built-in crossover zero. The vacuum pole amplitudes are constrained to satisfy the relation $\nu B^{(+)}/A^{(+)} = N$.

Good fits to πN charge exchange and elastic data are obtained for $N = -1$ and -2. The elastic crossover is well reproduced and is explained as a cooperation between the effect of the cut and having N negative. The effect of diffractive dissociation contributions to the Regge cut is considered. Their inclusion tends to worsen the fits. (auth)

1594 PHASE CONTOURS AND ZEROS OF FORWARD π^+–p SCATTERING AMPLITUDES IN THE COMPLEX ENERGY PLANE. Jorna, S.; McClure, J. A. (Georgetown Univ., Washington, D.C.). Nucl. Phys., B13: 68-72(1969).

Dispersion relations are employed to calculate the forward pion-nucleon scattering amplitudes $f^+(\omega)$ for complex ω. The small-scale structure and asymptotic behavior of the amplitudes are discussed with the aid of a constant phase diagram, while their zeros are calculated explicitly. (auth)

1595 PSEUDOSCALAR MESON PRODUCTION AND THE QUARK MODEL. Hofmokl, T. (Univ., Warsaw); Szeptycka, M. Nucl. Phys., B13: 53-6(1969).

Predictions of the quark model are compared with the experimental data for the production of the pseudoscalar meson and a strong disagreement is found for the π^0 and K^0 mesons. (auth)

1596 QUARK MODEL PREDICTIONS FOR JOINT DECAY DISTRIBUTIONS. Kotanski, Andrzej (Jagellonian Univ., Krakow); Zalewski, Kacper. Nucl. Phys., B13: 119-28(1969).

The non-linear as well as linear relations predicted by the quark model for joint decay distributions are compared with experiment. There are five new relations for each of the systems $K^*(890)N^*(1236)$, $\rho^0N^*(1236)$, $\omega N^*(1236)$ and three for the $N^*(1236)\bar{N}^*(1236)$ system. The agreement with experiment is very good. (auth)

1597 PARTIAL WAVE ANALYSIS OF THE REACTION $\pi N \to N\pi\pi$ BELOW 1 GeV. (I) π^-p INELASTIC INTERACTIONS. De Beer, M.; Deler, B.; Dolbeau, J.; Neveu, M.; Diem, Nguyen Thuc; Smadja, G.; Valladas, G. (CEN, Saclay, France). Nucl. Phys., B12: 599-616(1969).

A partial wave parametrization of the $\pi^-p \to n\pi^+\pi^-$ and $\pi^-p \to p\pi^-\pi^0$ reactions is attempted within the framework of the isobar model. The results are compared with phase-shift analyses of the elastic channel, and several fits are shown for the $(\pi\pi)_{T=J=0}$ interaction. (auth)

1598 SPIN, BRANCHING RATIOS, AND PRODUCTION CHARACTERISTICS OF THE K*(1420). Bassompierre, G. (CERN, Geneva); Drijard, D.; Goldschmidt-Clermont, Y.; (and others). Nucl. Phys., B13: 189-221(1969).

The reactions (1) $K^+p \to K^*(1420)p$ and (2) $K^+p \to K^*(1420)N^*(1236)$ are studied at 5 GeV/c incident K^+ momentum. The simultaneous fitting of the $K\pi$ and $K^*(892)\pi$ decay modes of the $K^*(1420)$ in the same production reaction makes it possible to eliminate 1^- as the spin of the $K^*(1420)$. The most likely $K^*(1420)$ spin-parity assignment is 2^+ although 3^- cannot be excluded. The various decay branching ratios of the $K^*(1420)$ are determined. The ratio of the $K^*(892)\pi$ to the $K\pi$ decay modes is found to be 0.9 ± 0.2. The peripheral production of the $K^*(1420)$ seems to be due predominantly to vector-meson exchange in reaction (1) and to pion exchange in reaction (2). (auth)

1599 DUALITY CONCEPT AND INELASTIC MESON–NUCLEON SCATTERING AT 1 TO 3 GeV/c. Minami, Shigeo (Osaka City Univ.). Progr. Theor. Phys. (Kyoto), 42: 299-304(Aug. 1969).

The amplitude for the $K^-p \to \pi\Sigma$ reaction in the forward direction is studied in order to examine the correspondence between the K^*-exchange amplitude in the t-channel and the resonant amplitude in the s-channel. It is shown that the requirement of duality is approximately satisfied. The structure of $d\sigma/d\Omega$ in the forward or backward direction is predicted. (auth)

1600 CAN $Y_0^*(1405)$ BE A FOUND STATE OF THREE QUARKS? Rajasekaran, G. (Tata Inst. of Fundamental Research, Bombay). Symp. Theor. Phys. Math., 9: 43-9(1969).

From Symposium on Theoretical Physics and Mathematics, Madras, India. See CONF-680121.

It is investigated whether from the experimental knowledge of the scattering amplitudes alone one can determine whether a particular hadron is a composite of other observed hadrons or a bound state of heavy quarks. It is pointed out that there exists a simple criterion which may allow one to choose between the two possibilities. The K-matrix for the relevant observed hadron channels should have a pole near the mass of the hadron considered if this hadron is a composite of heavy quarks. It is noted that the K-matrix also should have a pole in the neighborhood if the particle is formed by quark forces. The K-matrix was previously determined for $\pi\Sigma$ and $\bar{K}N$ channels by a phenomenological fit to the experimental data on $\bar{K} + N$ scattering. The K-matrix does not have a pole near the $Y_0^*(1405)$, and thus it is concluded that most probably $Y_0^*(1405)$ is not a bound state of three quarks. The process $\bar{K} + N \to \pi + \Sigma$ is considered. (J.F.P.)

1601 A COMMENT ON THE u = 0 SUPERCONVERGENT SUM RULE FOR πN SCATTERING. Agarwal, B. K.; Seth, V. P.; Sharma, M. C. (Allahabad Univ., India). Progr. Theor. Phys. (Kyoto), 42: 411-3(Aug. 1969).

The combination $A + m_N B$ approach for the u = 0 superconvergent sum rules for $\pi + N$ scattering is re-examined. Certain omissions in previous calculations are avoided. (J.F.P.)

1602 LOW-ENERGY PION–NUCLEON SCATTERING AND STATIC PAIR SUPPRESSION. Ishida, Shin (Nihon Univ., Tokyo). Progr. Theor. Phys. (Kyoto), 42: 420-1(Aug. 1969).

The pion–nucleon system is considered, and the low-energy behavior of P-wave and S-wave scattering is discussed with application of the following postulate: In the static limit where all participating particles are at rest, the quark number and the antiquark number are separately conserved. In those channels of a vertex where this condition is not met, the amplitude vanishes in the static limit. (J.F.P.)

1603 REGGE-DAUGHTER HYPOTHESIS IN THE QUARK MODEL. Morita, Katsusada (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 42: 370-84(Aug. 1969).

The internal Lorentz group generated by orbital and spin transformations on a quark-antiquark system is utilized to introduce the Regge-daughter hypothesis into the quark model. Perturbation solutions of the Domokos–Surányi type are found (to second order) to an eigenvalue equation which is assumed to determine functional form of any trajectory at the quark level. Particle spectrum in the symmetry limit with no spin-orbit couplings is described by four (five if parity doublet is counted as two) Regge families with only two unknown parameters in the linear approximation. The new Gell–Mann–Zweig scheme is reproduced in the model. (auth)

1604 F/D RATIOS AND ODD-PARITY BARYON RESONANCES. Shiga, Kunio; Kaiba, Masyuki (Kyushu Univ., Fukuoka. Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto), 42: 317-31(Aug. 1969).

The F/D ratios of baryon resonance decays into the $J^P = \frac{1}{2}^+$-octet baryon and pseudoscalar meson are determined on the basis of the nonrelativistic quark model. The classification of the odd parity baryon resonances into the $(70,3)^-$-supermultiplet of $[SU(6) \times O(3)]^{Parity}$ group is made in comparison between the calculated F/D ratios and the experimental data. It is found that the $(70,3)^-$-classification gives a reasonable interpretation for the odd parity baryon resonances. In particular, the spin-parity of $\Xi^*(1930$ MeV) is most probably $J^P = \frac{5}{2}^-$ in this approach. However, $N_\delta^*(1700$ MeV) is not classified into $(70,3)^-$-supermultiplet for various reasons such as the F/D ratio, the mass and the total decay width. In addition, a short discussion is made on the even parity baryon resonances using the F/D ratios. (auth)

1605 FIELD-CURRENT IDENTITY AND NUCLEON ISOVECTOR FORM FACTOR. Fukuda, Reijiro (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 42: 332-8(Aug. 1969).

The calculation of the nucleon isovector form factor within the framework of the so-called field-current identity is reported. The ρNN vertex is calculated under the assumption of 2π dominance and for the $N\bar{N}$–$\pi\pi$ amplitude, both the effects of correlating and noncorrelating contributions are included. Then, the charge form factor $F_1^V(t)$ is fairly well reproduced, but as for the magnetic form factor $F_2^V(t)$, there seems to be a discrepancy between theory and experiment. (auth)

1606 $\pi N \to \eta N$ SCATTERING IN THE VENEZIANO MODEL. Miyamura, Osamu (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto), 42: 305-16(Aug. 1969).

The Veneziano amplitude for $\pi N \to \eta N$ scattering is constructed including N_α, N_β, N_γ, N_δ, and A_2 Regge trajectories. The simplest amplitude is investigated and compared with the experimental data. If the trajectories are suitably fixed and certain conditions for the pole structure are set, the amplitude shows remarkable agreement and consistency with the experimental data over the whole energy region. The shape of high energy $\pi N \to \eta N$ differential cross section is reproduced and no dip occurs at $\alpha_{A_2} = 0$ (A_2 trajectory chooses Gell–Mann mechanism). The $NN\eta$ coupling is predicted to be $g^2_{NN\eta}/4\pi = 0.85$. The $J^P = (\frac{1}{2})^-$ pole near 1530 MeV has large $N\pi$-$N\eta$ coupling corresponding to the predominantly large $N\eta$ coupling of $S_{11}(1550)$. Adler's self-consistency condition is approximately satisfied. The I = 1, $J^{PC} = 0^{2+}$ meson appears near 850 MeV corresponding to the $\pi_V(980)$ meson. (auth)

1607 DUALITY NON-PRESERVING LEADING REGGE CUTS AND POLARIZATIONS IN HYPERCHARGE EXCHANGE REACTIONS. Krzywicki, A.; Tran Thanh Van, J. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Phys. Lett., 30B: 185-8(Sept. 29, 1969).

The implications for the Regge cut phenomenology of a non-vanishing slope of the Pomeranchon are discussed. A relation between polarizations in reactions related by $s \longrightarrow u$ crossing is derived. An explanation is proposed for the large, positive polarization observed in $K^-n \rightarrow \Lambda^0\pi^-$. (auth)

1608 INFLUENCE OF SPIN AND PHASE EFFECTS ON THE OVERLAP FUNCTION IN THE REACTION $\pi^+p \rightarrow \rho^+p$. Ajduk, Z.; Stroynowski, R. (Univ. of Warsaw). Phys. Lett., 30B: 179-81 (Sept. 29, 1969).

Overlap functions were calculated for the reaction $\pi^+p \rightarrow \rho^+p$ at 8 GeV/c. In the calculations the experimental differential cross section was supplemented by a model dependent description of spin and phase phenomena. The inclusion of these phenomena considerably increased the slope of the overlap function which became steeper than the total inelastic overlap function determined from elastic scattering. For all tested models (peripheral, absorption, and Regge) the angular momenta are much higher than those computed with spin and phase effects being neglected. (auth)

1609 PROBLEM OF CORRECT MASS CALCULATION OF THE $\frac{1}{2}^-$ MULTIPLET. Kostyrko, I. I. (Inst. of Mathematics, Kiev). Ukr. Fiz. Zh., 14: 254-6(Feb. 1969). (In Russian).

The comparison of theoretical and experimental decay probability ratios for the $\frac{1}{2}^-$-multiplet-resonances is carried out. Plausibility of the mass values calculated earlier results from this comparison. (auth)

1610 OFF-ENERGY-SHELL IN PROTON–PROTON BREMSSTRAHLUNG AT 99 MeV. McGuire, J. H.; Cromer, A. H. (Northeastern Univ., Boston). Phys. Rev., 184: 1018-19(Aug. 20, 1969).

Calculations of the proton-proton bremsstrahlung cross section using off-energy-shell pole amplitudes are compared with calculations in which the off-energy-shell dependence is suppressed. The differences in these cross sections and $4\frac{1}{2}$ times greater than the errors in the 99-MeV measurements of Sannes, Trischuk, and Stairs, and the off-energy-shell calculation clearly give the better agreement with these data. (auth)

1611 FORWARD pi–p SCATTERING AND A MODIFIED INTERFERENCE MODEL. Minami, Shigeo; Sasaki, Koushi (Osaka City Univ.). Progr. Theor. Phys. (Kyoto), 42: 275-81(Aug. 1969).

Forward π-p elastic scattering at 1.5 to 5 GeV/c is described in terms of the amplitude due to a modified interference model. The results are in good agreement with data. The existence of new parity doublets of nucleon resonances is discussed on the basis of the results. (auth)

1612 EXISTENCE OF THE A_2' MESON. Kawaguchi, Norio (Osaka Univ.). Progr. Theor. Phys. (Kyoto), 42: 292-8(Aug. 1969).

The continuous moment sum rule for kaon-nucleon scattering is evaluated to obtain information about A_2-type Regge poles. Further evidence for the existence of the A_2' meson is provided. It is found that a good fit to this sum rule is given by the values $0.30 < \alpha_{A_2} < 0.70$ and $0 < \alpha_{A_2'} < 0.12$, where the α's are zero-intercepts of the Regge trajectories. The candidates for the A_2' meson are also discussed. (auth)

1613 VECTOR MESON DOMINANCE AND HIGH-ENERGY BEHAVIOR. Le Bellac, M.; Plaut, G. (Laboratoire de Physique Theorique, Nice). Nuovo Cim., 64A: 95-107(Nov. 1, 1969).

Assuming that four of the six Mandelstam invariants which describe vector meson production are independent of the vector meson mass λ, it is shown that vector meson dominance must be written in the helicity frame. It is pointed out that this assumption cannot be justified with kinematical arguments only, and it is shown that it is correct at high energy in various models, including evasive and conspiring Regge-pole exchange, as well as Regge-pole model with absorption. However difficulties remain with trajectories of the A_1 and B type. (auth)

1614 CURRENT-FIELD COMMUTATORS AND THE BARYON SPECTRUM. Genz, H.; Katz, J.; Wagner, S. (Univ., Hamburg). Nuovo Cim., 64A: 218-24(Nov. 1, 1969).

The equal-time commutator between the time component of the axial vector current and the baryon field is assumed to be proportional to the field itself. The technique of Sugawara is used to fix the proportionality factor r in the commutator. Consideration of the P_{33} resonances $\Delta_\alpha(1236)$ and $\Delta_\beta(1688)$ together with the D_{33} resonance $\Delta_\gamma(1691)$ gives three possible values of $|r|$. Study of the S_{11} resonance $N_\alpha(1709)$ together with the P_{11} baryons $N_1(940)$ and $N_2(1466)$ shows that the experimental decay widths $\Gamma(N_\alpha \rightarrow N_1 + \pi)$ and $\Gamma(N_2 \rightarrow N_1 + \pi)$ select $r \approx \pm 1.2$. The value of $|r|$ so obtained is in agreement with that which one can deduce using the Jacobi identity and current algebra. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 1505, 1665, 1773, and 1913.

1615 (INP–679) LECTURES ON HIGH-ENERGY SCATTERING OF COMPOSITE HADRONS. Czyz, W. (Institute of Nuclear Physics, Krakow (Poland)). Feb. 1969. 60p. Dep. CFSTI (U. S. Sales Only).

The high-energy scattering of strongly interacting particles is discussed and illustrated mainly by high-energy nuclear scattering. (auth)

1616 (JINR–E2-4607) INELASTIC INTERACTIONS OF PIONS AND NUCLEONS WITH NUCLEI AT HIGH AND SUPER-HIGH ENERGIES (INTRANUCLEAR CASCADES, MULTIPLE-PARTICLE INTERACTIONS). Barashenkov, V. S.; Gudima, K. K.; Eliseev, S. M.; Iljinov, A. S.; Toneev, V. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1969. 27p. (CONF-690914-3). Dep. CFSTI (U. S. Sales Only).

From 3rd International Conference on High Energy Physics and Nuclear Structure, New York.

The mechanism of intranuclear cascades which is in good agreement with the presently available experimental data on inelastic pion- and nucleon-nucleus interactions in the whole energy range from a few dozens of MeV to a few GeV comes in contradiction with them at higher energies ($T \gtrsim 5$ GeV). To eliminate these disagreements it is necessary to take into account many-particle interactions, production of resonons and changes in the nuclear matter density as the intranuclear cascade develops. The analysis of the experimental data at energies $T \gtrsim 100$ GeV is a unique possibility for investigating a new type of elementary particle interactions when in the initial state three, four or more particles (multiple particle interactions) rather than two, as is usually the case, are involved in the collision. (auth)

1617 (JINR–P1-4666) QUANTUM STRUCTURE OF THE MEAN-SQUARE TRANSVERSE MOMENTA OF PROTONS IN THE HIGH-ENERGY ELASTIC COLLISIONS. Tolstov, K. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1969. 9p. (In Russian). Dep. CFSTI (U. S. Sales Only).

It is shown that in the elastic p–p scattering at high energies the differential cross sections can be expressed by a formula obtained on the basis of interference of the waves connected with the discrete values of the mean-square transverse momenta. (auth)

1618 THEORETICAL INVESTIGATION OF PION ABSORPTION ON ^{4}He. Lazard, C. (Institut de Physique Nucleaire, Orsay, France); Ballot, J. L.; Favier, J. Nuovo Cim., 63A: 1001-25(Oct. 21, 1969).

An analysis is made of the π^+ absorption on ^{4}He nucleus, considering the Born terms corresponding to the absorption of the π^+ on a pair of nucleons. Total cross section as well as missing-mass spectrum, recoil momenta and Treiman–Yang angle spectra are estimated and are in a good agreement with experiments. (auth)

1619 REACTION MECHANISMS IN PION PRODUCTION IN HIGH ENERGY PROTON–PROTON COLLISIONS. Clegg, A. B. (Univ. of Lancaster, Eng.). Nucl. Phys., B13: 222-30(1969).

In production of single pions in high-energy proton-proton collisions a large peak is found at low masses in the nucleon-pion system produced at low-momentum transfer with zero charge transfer. The evidence for this peak is reviewed, including extraction from published data of evidence for its production at 10 GeV/c. It is shown how charge independence shows that most of the component of this peak with a mass less than 1.35 GeV/c^2 cannot be due to production of nucleon isobars, therefore demonstrating that an important part of this production must be due to some other mechanisms, casting doubt on some reports of observation of production of nucleon isobars. Several related points are discussed. (auth)

1620 SCATTERING OF DEUTERONS AT HIGH ENERGY. Wolters, G. F. (Univ., Amsterdam). Ned. Tijdschr. Natuurk., 35: 81-112(Mar.-Apr. 1969). (In Dutch).

The properties of the deuteron were summarized and some general statements were made on the deuteron as a scattering center

for xd collisions at high energy. A first estimation of the correction $\delta\sigma_{abs}$ was made, based on the shadow effect. The high energy approximation obtained by a more refined treatment was given. The composition of the xd scattering amplitudes with singular xp and xn amplitudes was determined. The utilization of the differential and total cross sections was described. The relativistic treatment of xd scattering problems was then considered. (tr-auth)

1621 NUCLEAR PRODUCTION AS A TECHNIQUE FOR DISTINGUISHING BETWEEN KINEMATIC ENHANCEMENTS AND RESONANCES. Trefil, J. S. (Univ. of Illinois, Urbana). Phys. Rev. Lett., 23: 1075-8(Nov. 3, 1969).

The problem of distinguishing between kinematic enhancements and true resonance production is discussed. It is shown that a systematic study of production on nuclei should provide a way of making this distinction. (auth)

1622 NUCLEON–NUCLEON P AND D SCATTERING PHASE SHIFTS BY THE NAMBU–SALPETER–BETHE EQUATION. PS(ps) COUPLING CASE. Noda, Matu-Tarow (Osaka City Univ.). Progr. Theor. Phys. (Kyoto), 42: 355-69(Aug. 1969).

The Nambu–Salpeter–Bethe equation (the so-called Bethe–Salpeter equation) in the pion-ladder approximation is solved numerically for the P- and D-wave states of nucleon–nucleon scattering. Further the negative energy contribution (pair effect) is neglected. According to the magnitude of the difference between these phase shifts and Born phase shifts, the results are classified to four types. The magnitude is qualitatively governed by three factors and this classification indicates the difference between the calculations and the 3-dimensional or the dispersion theoretic results. Two bound states of the nucleon–nucleon system appear in the $^3P_0$ state in the calculation, but no bound state is found in this state by calculation of dispersion theory. This difference shows the contribution from the left-hand cut due to the many-particle exchange of the ladder type. On the other hand, the quantitative differences with the 3-dimensional calculation in the $^3D_2$ and $^1P_1$ states are seen. These differences are due to the retardation effect. (auth)

Particle Invariance Principles and Symmetries

General

1623 (ITF–69-33) BARGMAN–WIGNER EQUATIONS ON THE INHOMOGENEOUS DE SITTER GROUP. Fushchich, V. I.; Sokouor, L. P. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 38p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The equations of the Bargman–Wigner type invariant under the inhomogeneous de Sitter group P(1,4) (the rotation and translation group in the five-dimensional plane Minkowski space) are constructed. A detailed group-theoretical analysis of these equations is carried out. The explicit form of the generators of the group P(1,4) is derived for the case when the basic invariants of this group $P^2 = W = V = 0$. The question of the invariance of the Bargman–Wigner equations under the P-, T-, C- transformation is considered. (auth)

1624 THE CONVOLUTION OF FOURIER TRANSFORMS AND ITS APPLICATION TO THE DECOMPOSITION OF THE MOMENTUM OPERATOR ON THE HOMOGENEOUS LORENTZ GROUP. Ruehl, W. (CERN, Geneva). Nuovo Cim., 63A: 1131-62(Oct. 21, 1969).

The analytic structure of the Clebsch–Gordan coefficients of the homogeneous Lorentz group is studied. It is shown that their poles are connected with tensor operators, in particular that four pairs of poles give rise to the four types of generalized Dirac matrices. As an application the momentum operator of the inhomogeneous Lorentz group is decomposed into a direct integral of generalized Dirac matrices for the homogeneous Lorentz group. (auth)

1625 THE $O_{3,1}$ ANALYSIS OF CURRENT MATRIX ELEMENTS AND THE ASYMPTOTIC EXPANSION OF FORM FACTORS. Ruehl, W. (CERN, Geneva). Nuovo Cim., 63A: 1163-87(Oct. 21, 1969).

Matrix elements of current density operators between single-particle states are submitted to harmonic analysis on the homogeneous Lorentz group. (auth)

1626 ON THE BREAKING OF $SU_3 \times SU_3$ SYMMETRY. Renner, B.; Sudbery, A. (Cambridge Univ., Eng.). Nucl. Phys., B13: 27-32(1969).

The possible transformation properties of the energy operator under the chiral $SU_3 \times SU_3$ algebra are investigated, assuming that it transforms as a singlet and the eighth component of an octet under SU_3 and has certain simple transformation properties under the non-strange chiral $SU_2 \times SU_2$. It is shown that the $SU_2 \times SU_2$ invariant part of the energy operator can only belong to the representations $(1,8) + (8,1)$ and $(3,3^*) + (3^*,3)$ of $SU_3 \times SU_3$, as suggested by Gell-Mann, Oakes and one of the authors. Making the further assumption that the remaining part of the energy operator belongs to a four-dimensional multiplet under the nonstrange chiral $SU_2 \times SU_2$ (i.e., the pion σ-terms are isoscalar), the possible $SU_3 \times SU_3$ transformation properties are found. (auth)

1627 NEW QUANTUM NUMBER DERIVED FROM CONFORMAL INVARIANCE. Castell, L. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nucl. Phys., B13: 231-6(1969).

A detailed analysis of the conformal group of relativistic space-time, and its four-dimensional homogeneous spaces shows that for example the mass 0 scalar field in the appropriate (not the usual) conformal compactification of Minkowski space carries a unitary representation not of the conformal group $SO_0(4.2)/C_2$, but of its covering group $SO_0(4.2)$. The invariant definition of causality is given, and the representations to mass 0 of the spin-covering group $SU_3(2.2)$ of the conformal group are investigated. The physical consequences are either the existence of a new conserved multiplicative quantum number R for conformal symmetry (the corresponding selection rule would for example forbid the process spin $0 \rightarrow 2\gamma$ for mass 0 particles), or the prediction that all possible mass 0, spin $|s| \leq 2$ particles are given by the γ-quantum, one type of neutrino (the left-handed for example), and a spin $\frac{3}{2}$ particle whose helicity has the opposite sign. (auth)

1628 REALIZATION OF THE ALGEBRA OF ISOVECTOR CHARGE DENSITY AND THE LORENTZ GROUP. MASS SPECTRA AND FORM FACTORS. Miyazaki, Tadashi (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 42: 346-54(Aug. 1969).

Various possible representations of the algebra of the isovector charge-density are discussed group-theoretically with the particles assigned by some representations of O(3, 1), E_2, O(4, 2) or O(3, 3). Form factors are calculated and the Regge mass spectrum is obtained from the results of one of the solutions. (auth)

Applications (Electromagnetic and Weak)

Refer also to abstracts 1503, 1506, 1507, and 1796.

1629 INTERMEDIATE VECTOR MESONS AND CP-VIOLATIONS. Okubo, S. (Univ. of Rochester, N. Y.). Symp. Theor. Phys. Math., 9: 1-8(1969).

From Symposium on Theoretical Physics and Mathematics, Madras, India. See CONF-680121.

A scheme is proposed for weak interactions where the CP violation is maximal and there are maximal violations of separate P and C invariances. The fundamental postulates are that there exist intermediate vector mesons and they have a strong trilinear interaction among themselves, but have only weak and electromagnetic interactions with all other particles, and that the weak interaction Hamiltonian is linearly proportional to the W field and has CP = −1. (J.F.P.)

1630 ASYMPTOTIC SYMMETRIES AND WEAK BARYON FORM FACTORS. Divakaran, P. P. (Tata Inst. of Fundamental Research, Bombay). Symp. Theor. Phys. Math., 9: 21-31(1969).

From Symposium on Theoretical Physics and Mathematics, Madras, India. See CONF-680121.

A systematic discussion is given for the implications of some assumed asymptotic symmetries for the weak form factors of baryons. The discussion covers construction of superconvergent form factors and chiral SU(3) × SU(3) and SU(3) as asymptotic symmetries. (J.F.P.)

1631 SOME DIFFICULTIES WITH OAKES' THEORY OF CP-VIOLATION. Gronau, M. (Tel-Aviv Univ., Israel). Phys. Lett., 30B: 196-7(Sept. 29, 1969).

The angle ϕ introduced by Oakes in his theory of CP-nonconservation is re-estimated. With the obtained value, disagreement is established between the predicted values of the K_L-K_S mass difference and the $K^+ \rightarrow \pi^+ + \nu + \bar{\nu}$ amplitude and the experimental observations. (auth)

1632 TEST OF TIME-REVERSAL INVARIANCE AND MEASUREMENTS OF POSITRON AND NEUTRINO ASYMMETRIES IN POLARIZED ^{19}Ne BETA DECAY. Calaprice, Frank P. (Univ. of California, Berkeley); Commins, Eugene D.; Gibbs, Hyatt M.; Wick, Gerald L.; Dobson, David A. Phys. Rev., 184: 1117-29(Aug. 20, 1969).

A comprehensive discussion is presented of an experiment, previously reported, to test time-reversal (T) invariance in the β decay of ^{19}Ne. The "time-reversal" coefficient D, as well as the neutrino and positron asymmetry coefficients B and A, respectively, is measured, with results as follows: $D = +0.002 \pm 0.014$, $B = -0.90 \pm 0.13$, and $A = -0.039 \pm 0.002$. The value of D, based on 30,000 events, is consistent with T invariance: T invariance implies D = 0, since final-state corrections to D are negligible. The atomic-beam method is used to form a nuclear-spin polarized beam of ^{19}Ne atoms in the $^1S_0$ ground state. Coefficients D and B are measured by observing correlations between the positron and recoil ion $^{19}F^-$ (in delayed coincidence) with respect to the ^{19}Ne spin polarization, from decays in flight. The beam terminates in flight in a cell where ^{19}Ne atoms are captured and remain for approximately 3 sec but suffer no significant depolarization. Positrons emitted parallel and antiparallel to the spin by ^{19}Ne decaying in the cell are counted to measure A. The results of the measurements are compared with similar observations of the β decay of polarized neutrons. (auth)

1633 SU(2) × SU(2) SYMMETRY BREAKING AND $\eta \to 3\pi$. Oakes, R. J. (Northwestern Univ., Evanston, Ill.). Phys. Lett., 30B: 262-3(Oct. 13, 1969).

The hadron energy density discussed in a previous investigation of the relation between the breaking of chiral SU(2) × SU(2) symmetry and the Cabibbo angle θ is shown to yield $\eta \to \pi^0\pi^0\pi^0$ and $\eta \to \pi^+\pi^0\pi^-$ decay amplitudes which are in reasonably good agreement with experiment. (auth)

Applications (Strong)

Refer also to abstracts 1566 and 1604.

1634 ASYMPTOTIC NONET SYMMETRY AND $g_{\phi\rho\pi}/g_{\omega\rho\pi}$. Clavelli, L. (Yale Univ., New Haven); Torgerson, R. Nuovo Cim., 63A: 1229-34(Oct. 21, 1969).

A model in which asymptotic nonet symmetry is broken further by a 27 term in a Weinberg II sum rule is studied. $m_\rho = (778.4 \pm 0.7)$ MeV and an intermediate mixing angle $\theta = (32.8 \pm 0.2)^0$ are predicted. Using asymptotic nonet symmetry for vertices, $g_{\phi\rho\pi}/g_{\omega\rho\pi} = 0.033 \pm 0.002$ is calculated. (auth)

1635 SU_3-INVARIANT SPINOR THEORY WITHOUT QUARKS. Saller, H.; Duerr, H. P. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nuovo Cim., 64A: 145-83(Nov. 1, 1969).

A phenomenological spinor theory is developed which incorporates SU_3 symmetry in the form of octet spinor fields rather than triplet quark fields. This allows the use of more conventional procedures in attacking the dynamical problem. A development of such a SU_3 theory based on Weyl spinors proves too restrictive, since, in particular, it is unable to produce a nontrivial F/D ratio for the 0^--boson-octet-baryon interaction in the lowest approximation. Hence the main emphasis is based on theories involving Dirac spinor fields. It is demonstrated that in the octet formulation the Weyl-type V−A interaction is the only four-spinor interaction which has exactly $SU_3 \times SU_3$ as maximal internal symmetry group (besides the two gauge groups). The $SU_3 \times SU_3$ invariant interactions involving Dirac-scalar terms have higher symmetry. For theories involving among others a scalar interaction an appropriate regularization procedure allows one to formulate the continuity equations for the currents in the conventional form. Mass values and coupling constants for the simplest baryon and boson multiplets can be calculated in terms of one free regularization constant. There exists a uniquely determined SU_3-breaking four-spinor interaction which is proportional to an octet operator and does not mix SU_3 multiplets. The formalism is exemplified in some preliminary models. (auth)

1636 ON THE ASYMPTOTIC BEHAVIOUR OF MESON SCATTERING AMPLITUDES IN CHIRAL SYMMETRY. Renner, B. (Cambridge Univ., Eng.). Phys. Lett., 30B: 260-1(Oct. 13, 1969).

It is shown, without the use of Regge theory, that in the chiral $SU_2 \times SU_2$ symmetry limit meson scattering amplitudes require at least one subtraction in forward scattering dispersion relations. Without further assumptions, the need for a subtraction can be shown only for the singlet exchange channel. In the limit of chiral $SU_3 \times SU_3$ symmetry, the argument can be generalized to require a subtraction also in the crossing-even octet exchange channel, if certain assumptions are added concerning the neglect of exotic channel contributions. (auth)

Field Theories

Quantum Field Theory

Refer also to abstracts 1531, 1635, and 1667.

1637 (JINR-E2-4692) INVESTIGATION OF EIKONAL APPROXIMATION IN QUANTUM FIELD THEORY BY FUNCTIONAL INTEGRATION METHOD. Barbashov, B. M.; Kuleshov, S. P.; Matveev, V. A.; Sissakian, A. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1969. 23p. Dep. CFSTI (U. S. Sales Only).

The efficacy of the functional integration method in quantum field theory for the study of the validity of the eikonal representation in the relativistic region and the structure of the effective quasipotential of two spinless particles at high energies is demonstrated. A closed relativistically invariant and cross-symmetrical analytic expression for the scattering amplitude of two spinless "nucleons" in the model $L_{int} = g: \Psi^2\phi$ is obtained. (J.F.P.)

1638 ELEMENTARY AND COMPOSITE PARTICLES IN FIELD THEORY AND IN S-MATRIX THEORY. Kang, K. (Brown Univ., Providence); Land, D. J. Nuovo Cim., 63A: 1053-73 (Oct. 21, 1969).

The definition of a particle as elementary or composite and the decomposition of the scattering amplitude into one-particle reducible and irreducible parts for both types of particles are re-examined. For the composite-particle solution the decomposition is based on identifying the field-theoretic quantities for the composite particle with the corresponding quantities for the elementary particle. The cancellation mechanism between the poles of the proper vertex function and the zeros of the propagator even when the propagator satisfies a once-subtracted Källén–Lehmann representation is proved, so that vertex poles do not lead to poles in the scattering amplitude. The dynamical origin of the vertex poles is discussed. The compositeness conditions used by other authors are discussed and it is shown how these conditions follow from our construction of the various field-theoretic and S-matrix quantities. However, it is found that the popular compositeness conditions $Z_3 = 0$, $Z_1 = 0$ are not sufficient to obtain the composite particle in field theory without a restriction on the propagator. The asymptotic behavior of both field-theoretic and S-matrix quantities is discussed briefly. (auth)

1639 BEHAVIOR OF INTERACTING FIELDS ON THE LIGHT CONE. THE PSEUDOSCALAR CASE. Marioni, C. (Univ., Milan). Nuovo Cim., 63A: 921-30(Oct. 21, 1969).

In order to extend some results obtained in a previous paper, a pseudoscalar boson field coupled with a fermion field is considered. By means of general methods, developed along the lines of the Heisenberg philosophy, the leading singularities on the light cone of the commutators and the anticommutators are studied. The results indicate that the behavior of the fermion field is not consistent with the assumption of a positive-definite metric. (auth)

1640 CANONICAL COMMUTATION RELATIONS FOR RENORMALIZED FIELDS. Ingraham, R. L. (New Mexico State Univ., Las Cruces). Nucl. Phys., B13: 113-18(1969).

It is proved that canonical commutation relations, $[\phi_R(x), \phi_R(y)] = -i\delta(x - y)$ at equal times, can be demanded for renormalized fields ϕ_R while retaining the accepted field equations defined by a Lagrangian L. One uses the fact that the correct Hamiltonian is not the one derived by the canonical prescription from L, but such a one modified by the insertion of a Z-dependent parameter, as actually found necessary long ago in counter term renormalization theory (Gupta, Dyson), in order to make S Lorentz invariant (i.e., frame-independent). It is proved that demanding frame-independence of S or canonical commutation relations for the renormalized field determines exactly the same modified Hamiltonian. (auth)

1641 RENORMALIZATION OF THE σ-MODEL. III. FERMION FIELDS AND REGULARIZATION. Gervais, J. L. (Faculte des Sciences, Orsay, France); Lee, Benjamin W. Nucl. Phys., B12: 627-46(1969).

The renormalization of the σ-model is discussed. The results presented here generalize a previous study where only the boson terms were considered. It is emphasized that a consistent renormalization, namely one which is obtained by a mere redefinition of the bare constants of the Lagrangian, and by introducing chiral symmetric mass counter terms, can only be achieved by an appropriate choice of the regularization procedure. It is shown that this will be the case only if the same regularization can be applied to the chiral symmetric theory, i.e., the one where the scalar tadpoles are absent (in particular, the fermion mass is zero). As a consequence it is shown that one cannot regularize by adding fermion fields with the same chiral properties as the nucleon. In particular Bell and Jackiw's prescription is excluded as inconsistent. A new regularization procedure is proposed based on parity doublets. It is shown to lead to a consistent renormalization of the σ-model, in particular PCAC is obtained among renormalized quantities. This method, however, does not regularize the triangle graph discussed by Bell and Jackiw and Adler. It is

thus concluded that two types of regulators are needed in the σ-model when electromagnetism is superimposed. (auth)

1642 A GENERAL SURVEY OF THE THEORY OF THE BETHE–SALPETER EQUATION. Nakanishi, Noboru (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), Suppl. No. 43, 1-81(1969).

The theory of the Bethe–Salpeter equation is reviewed extensively. The main effort is devoted to describing systematically the theoretical results rather than numerical calculations and applications of the Bethe–Salpeter equation. An almost complete bibliography of the Bethe–Salpeter equation also is presented. (auth)

1643 SYMMETRY TRANSFORMATIONS FROM LOCAL CURRENTS. Maison, H. Dieter (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Commun. Math. Phys., 14: 56-66(Sept. 15, 1969).

For internal symmetries it is shown that it is possible to construct automorphisms for a Haag-Araki local ring system $\{R(O)\}$ from a local current affiliated to it. Although the "charges" Q_V for finite volume V do not converge for $V \to \infty$, the convergence of the corresponding automorphisms of $\{R(O)\}$ is proven. For external symmetries which map bounded space-time regions into unbounded ones (e.g., translations) some additional continuity condition on the isomorphisms corresponding to Q_V is required to get convergence. (auth)

1644 EQUIVALENCE OF ADDITIVE AND ANALYTIC RENORMALIZATION. Hepp, Klaus (Eidgenoessische Technische Hochschule, Zurich). Commun. Math. Phys., 14: 67-9 (Sept. 15, 1969).

The equivalence of additive and analytic renormalization is proved for any choice of finite renormalizations and any fixed generalized evaluator. (auth)

1645 A CLASS OF FIELD THEORIES IN TWO-DIMENSIONAL SPACE–TIME WITH A $U_1 \times U_1$ SYMMETRY. Lehmann, H.; Pohlmeyer, K. (Univ., Hamburg). Commun. Math. Phys., 14: 78-88(Sept. 15, 1969).

The derivative coupling of massless pseudoscalar neutral particles with a charged spinor field in two-dimensional space-time is reduced to a self-interacting spinor field and a free pseudoscalar field. More generally, it is shown that any given local field theory with a conserved vector current and without massless particles can be extended to a local theory with an additional pseudoscalar field and with a $U_1 \times U_1$ symmetry. (auth)

1646 A TEST OF LORENTZ INVARIANCE USING A TORSION PENDULUM. Phillips, P. R.; Woolum, D. (Washington Univ., St Louis). Nuovo Cim., 64B: 28-36(Nov. 11, 1969).

A search was made for a preferred frame of reference in space. It is assumed that the velocity V of the earth in this frame is coupled to the spin of an electron through a term $GV \cdot \sigma$. The sensing element was a bar magnet on a torsion fiber. By looking for diurnal variations in the orientation of the pendulum, one can set a limit on the strength of the coupling. It is found that the two-spin states are unlikely to be split by more than $7.2(10^{-25})$ erg. This refines previous limits by a factor of 80. No violation of Lorentz invariance was found. (auth)

1647 REMARKS ON MASSLESS FIELDS WITH ARBITRARY SPIN. Omote, Minoru; Takaya, Yoshimasa (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto), 42: 394-401(Aug. 1969).

A massless field which belongs to the representation $(s, s+1) \oplus (-s, s+1)$ is considered, and it is expanded in terms of the bases of the representation of the inhomogeneous Lorentz group. It is proposed to impose a relativistically invariant, first order differential equation on this field. It is then shown that such a field has only two helicity states, and that the gage change of the field vanishes. Quantization of this field is also discussed. (auth)

1648 ON THE SPUR OF THE PRODUCT OF DIRAC MATRICES. Sarkar, S. (Indian Association for the Cultivation of Science, Calcutta). Acta Phys. Acad. Sci. Hung., 26: 239-46(1969).

Several methods for the evaluation of the spur of the product of γ_5 matrix and any number of Dirac matrices are established. The formulas for the determination of the various types of products of two spurs when γ_i, $\gamma_i\gamma_j$, $\gamma_i\gamma_j\gamma_k$, $\gamma_i\gamma_j\gamma_k\gamma_l$ and those terms associated with the γ_5 matrix occur in both of the spurs are derived. It is shown that the product of two spurs each involving the γ_5 matrix can be equated to an expression involving no γ_5 matrix. One useful identity for spurs involving the γ_5 matrix was deduced. (auth)

1649 INDISPENSABILITY OF NONLOCAL EXPRESSIONS FOR ENERGY- AND PARTICLE-DENSITY OF THE DIRAC-FIELD. II. Gerlach, Bernd (Univ., Marburg, Ger.). Z. Phys., 229: 44-56(1969). (In German).

In a previous paper it was proved that the usual expressions for energy- and particle-density are indefinite even in the one-particle subspace. Therefore an axiomatic approach is pursued in constructing definite quantities and a nonlocal theory is obtained. (auth)

1650 REFORMULATION OF THE FRENKEL–KRAMERS MODEL INCLUDING THE THOMAS PRECESSION WITH THE VELOCITY METRIC. Yamasaki, Hisaiti (Kyusyu Dental Coll., Japan). Progr. Theor. Phys. (Kyoto), 42: 234-44(Aug. 1969).

The relation between the Frenkel–Kramers model and the Thomas precession is investigated with new representation in which the hyperbolic metric V of velocity as well as the proper spin-direction vector ^0s are used. The formulation of the model is entirely without the complicated or too formal and abstract expressions which are usually accompanied with the relativistic theory, and reveals a physical picture hitherto hidden. This formulation shows succinctly and definitely that not only the spin precession but also the acceleration itself undergoes the Thomas precession in electromagnetic fields. On that occasion, the use of a new expression, $dV/d\tau$, of the proper acceleration also produces a simple invariant equation of motion as a substitute for the usual covariant equations of motion. (auth)

1651 REALITY OF THE EIGENVALUES OF THE BETHE–SALPETER EQUATION. Naito, Seichi; Nakanishi, Noboru (Tokyo Univ. Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 42: 402-7 (Aug. 1969).

The reality of the eigenvalues of the unequal-mass Bethe–Salpeter equation is proved in all ladder models of practical interest. Some remarks are made on the analyticity of the eigenvalues as functions of the invariant mass squared and on the Cutkosky–Deo phenomenon of the Regge trajectories. (auth)

1652 PARTICLE DESCRIPTION. Kulhanek, J. (Univ. of Windsor, Ont.). Nuovo Cim., 63B: 497-510(Oct. 11, 1969).

The equations of the de Broglie wave field (field equations) are solved for the metric with spherical symmetry under the coordinate conditions which guarantee that the particle is at rest in 3-space x^0 = constant. In this case the field equations admit a solution which includes both the Schrödinger and Hamilton-Jacobi methods of description as the particular cases. The Schrödinger method leads to the conclusion that there is just one "bound" state with energy equal to the rest energy (mass) of particle. The Hamilton-Jacobi method gives the energy of particle as the function of "distance" from origin. For large value of rest mass, the functional dependence of energy on "distance" is given by the δ-function. (auth)

Gravitation and General Relativity

Refer also to abstracts 1242, 1245, 1253–1256, and 1258–1260.

1653 INTERIOR SPHERICALLY SYMMETRIC SOLUTION OF THE EINSTEIN FIELD EQUATIONS WITH THERMAL FLOW. Strobel, Hans (Theoretisch-Physikalisches Institut Jena, Ger.). Wiss. Z. Friedrich-Schiller-Univ., Jena, Math.-Naturwiss. Reihe, 17: 195-8(1968). (In German).

A method for the solution of the Einstein field equations for a 1-component fluid is developed with the inclusion of thermal flow. Assumptions of spherical symmetry in the co-moving frame of coordinates and vanishing shear are made. The simplest result is a line element; it includes, as special cases, well-known solutions without heat flow, and the solutions of Schwarzschild (interior), Friedman, and de Sitter. On the other hand, the solution for the general case is of irreversible character. Arbitrary functions of time enter, and the study may be a basis for further thermodynamic investigation. To this end the same functions must be defined by the results of thermodynamics; Gibbs' equations put definite limitations on magnitudes derived from both field equations and rest mass equations. (BBB)

1654 NATURAL QUANTITY IN THE GENERAL THEORY OF RELATIVITY AND THE PROBLEM OF CARTAN. Levashev, A. E. (White Russian State Univ., Minsk). Wiss. Z. Friedrich-Schiller-Univ., Jena, Math.-Naturwiss. Reihe, 17: 173-5(1968). (In German).

Three methods of describing physical processes in general relativity theory are usually distinguished: global, "local global" stimulated by Cartan, and that using only local quantities. The last method is described and defended, and applied to the motion of the planet Mercury. Special relativity theory is therefore that of a single local 4-dimensional space as if this were spread out through the whole Universe. The task of general relativity theory is the

explanation of variation of the time and space scales from local space to local space, i.e., the change of physical tetrads. This problem is solved for the gravitational field by the Einstein equation with use of the global method of description. The existence of three methods of description is a special expression of the general covariance principle; each method has its advantages and area of particular application. (BBB)

1655 MODELING PATHS OF TEST BODIES IN A GRAVITATIONAL FIELD. Petrov, A. Z. (Kazan State Univ.). Dokl. Akad. Nauk SSSR, 186: 1302-5(June 21, 1969). (In Russian).

The main method of studying a gravitational field consists in studying the behavior of test bodies in this field. Fundamental to Einstein's theory of gravity is the principle of geodesics, where test bodies move along geodesic lines (nonisotropic for bodies with nonzero rest mass; isotropic in the opposite case). It is shown that this principle can be considered a result of the field equation with certain assumptions of the structure of the mass tensor. The equation of motion of a test body is presented, and the question is asked whether there exists another Rieman space of the same signature which is modeled by the original field. The model should not be more complex than the original. Only total modeling of all time-like and isotropic values are considered. It was found possible to carry out this modeling. In particular, it is emphasized that a plane space can always be taken as the modeling space. This modeling can always be carried out, and is preferred in the sense of physical interpretation, since the gravitational field as a whole reduces to a gravitational force with such modeling. (TTT)

1656 SPACES OF SIMULTANEOUS EVENTS IN SPECIAL RELATIVITY THEORY. Nozicka, Frantisek. Wiss. Z. Humbolt-Univ. Berlin, Math.-Naturwiss. Reihe, 17: 705-20(1968). (In German).

A definite 3-dimensional manifold can be assigned to each point of a regular world line in Minkowski space that corresponds to the observer of a general non-inertial system. The 3-dimensional manifold has the significance of the space of simultaneous events with respect to the observer. These spaces along the world line represent a decomposition of the Minkowski space, and the metric induced in them is a Riemannian metric. Defined 2-dimensional manifolds are introduced and some of their properties are derived; then on the basis of these 3-dimensional manifolds are derived and assigned to each point of the world line. Geometrical results are physically interpreted. The principle of causality from the theory of inertial systems is extended to non-inertial systems; for 2 causally related events their occurrence in time is the same with respect to the observer in a given system, and therefore not exchangeable. (BBB)

1657 TWO EXAMPLES OF THE LOCAL-GLOBAL METHOD OF DESCRIPTION IN THE GENERAL THEORY OF RELATIVITY. Ivanitskaya, O. S. (Physical Inst., Minsk). Wiss. Z. Friedrich-Schiller-Univ., Jena, Math.-Naturwiss. Reihe, 17: 177-80(1968). (In German).

The first example, on relativistic rotational motion, shows that a definition of the rotating reference system through tetrads is in agreement with previous studies. In the local global method, anholonomity objects play an important role. It was previously shown that the tetrads can be obtained through Lorentz transformations; here they are evaluated through a system of ten equations, the fundamental tensor in the so-called rotating coordinate system and through tetrad normalization. The second example is related to the exterior Schwarzschild problem. The local descriptions of global simultaneity and those of the local reference system differ only by a factor. (BBB)

1658 PHYSICAL FOUNDATIONS OF GENERAL RELATIVITY. Sciama, D. W. Science Study Series. Garden City, N. Y., Doubleday and Company, Inc., 1969. 118p.

The topics covered are the problem of inertia, sources of inertial forces, law of inertial induction, equivalence principle, and Einstein red shift, Einstein's field equations, the motion of light in the sun's gravitational field, and the curvature of space-time. (J.F.P.)

1659 INTERPRETATION OF EINSTEIN'S THEORY OF GRAVITATION INCLUDING THE COSMOLOGICAL TERM AS A DE SITTER-INVARIANT FIELD THEORY ON THE DE SITTER SPACE. Fischer, Kurt (Univ., Cologne). Z. Phys., 229: 33-43 (1969).

In order to remove the singular nature of Einstein's theory of gravitation including the Λ-term, within the domain of field theories, it is shown that this theory can be consistently interpreted as a field theory on the fixed de Sitter space, invariant with respect to the de Sitter group O(4,1). The corresponding field equations as well as the equations of motion are derived, their structural properties are discussed, and they are integrated for a spherical mass source of the field. (auth)

1660 NEW EXACT STATIC SOLUTIONS OF EINSTEIN'S FIELD EQUATIONS. Heintzmann, H. (Univ., Cologne). Z. Phys., 228: 489-93(1969).

A method for deriving new solutions for an ideal fluid from old is described, and some new solutions are given which may be of interest in astrophysics. (auth)

Scattering Theory

Refer also to abstract 1638.

1661 (ITF-69-46) STRICT LOCALITY, MICROCAUSALITY AND THEOREMS OF TYPE OF THE POMERANCHUK THEOREM. Lomsadze, Yu. M.; Sabad, E. P. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 43p. (CONF-690417-17). Dep. CFSTI (U. S. Sales Only).

From 3rd Conference on Axiomatical Field Theory and Theory of Elementary Particles, Kiev, USSR.

Strict locality and microcausality principles are formulated both for the asymptotical $\tilde{T}_{as}(\kappa_0)$ and the strict $T(\kappa)$ amplitudes without whatever appealing to the temperateness of growth of the generalized functions $T(\tau)$ and $T(\chi)$. A close connection between these principles is established. It is shown that meeting of these principles, different from the Meyman locality and the strict localizability Jaffe principles, does not yet guarantee the theorems of the Pomeranchuk theorem type to be fulfilled. Additional conditions are found securing the validity of these theorems. (auth)

1662 CUSPS ON REGGE CUTS. Negrine, S. M. (Cambridge Univ., Eng.). Nuovo Cim., 63A: 1101-23(Oct. 21, 1969).

The sheet properties of Regge cuts are investigated by examining the singularity properties of the relevant perturbation-theory model integrals. A complete geometrical and hierarchial structure satisfying the Froissart bound is first established for the n-Reggeon cut generalizing recent work on the 2-Reggeon cut. It is found that all Regge cuts possess, in general, cusps in the physical region; this is established assuming only that Regge trajectories have positive slope below threshold. The essential features of these cusps are examined for different models for Regge-trajectory functions. A fully consistent picture in the l-plane is obtained showing that there are only real l-plane branch points of the Regge amplitude for real physical momentum transfer. A new feature is that each given n-Reggeon-exchange process ($n \geq 2$) in two-body scattering will contribute in general more than one such branch point when the momentum transfer is fixed at a suitable real negative value. It is shown how the full amplitude need not have the cusp singularities which occur in the Regge amplitude. (auth)

1663 VENEZIANO'S MODEL AND FREEDMAN-WANG DAUGHTER TRAJECTORIES. Scheck, F. (CERN, Geneva). Nuovo Cim., 63A: 1074-86(Oct. 21, 1969).

Veneziano's formula is analyzed in the complex l-plane for the case of unequal-mass scattering. The cancellation of unwanted singularities at $t = 0$, through the built-in daughter trajectories is discussed following the original analysis of Freedman and Wang. It is then shown how this analysis can be reversed to construct a general scattering amplitude of the Veneziano type, given the leading Regge trajectory, and assuming linear trajectories and crossing symmetry. (auth)

1664 RELATIVISTIC EXTENSION OF THE LE COUTEUR-NEWTON FORMALISM. Benayoun, M.; Lancien, J.; Leruste, Ph. (College de France, Paris). Nuovo Cim., 63A: 969-86 (Oct. 21, 1969).

Assuming T-invariance and extended unitarity, a multichannel relativistic extension of the LeCouteur-Newton formalism ("determinantal method") is studied. It is proved that the two above-mentioned assumptions are entirely sufficient to work out a D/D formalism as a particular solution of the relativistic multichannel problem, having the same form as the nonrelativistic solution. In this case the existence of a new formalism, denoted B/B, for the multichannel reduced-reactance K-matrix is also proved. The 2^n single-valued meromorphic functions $B_\lambda(s)$ give the multichannel K-matrix a structure, which is similar to the one given to the multichannel S-matrix, by the 2^n values of the many-valued meromorphic function D(s). Over-determination relations between the values of the D-function on the various sheets, and similar ones for the B_λ-functions are found and interpreted. Finally, it is proved that the D-function exists, and a simple application of the B/B formalism is given. (auth)

1665 MINIMAL SOLUTIONS TO THE CONSPIRACY PROBLEM AND CLASSIFICATION OF REGGE-POLE FAMILIES. II. Di Vecchia, P.; Drago, F. (CNEN, Frascati, Italy). Nuovo Cim., 63A: 1247-66(Oct. 21, 1969).

A non group-theoretical approach to the conspiracy problem, based on analyticity, crossing symmetry and factorization, is presented. The solutions to all the physically interesting cases are given. A classification of Regge-pole families is deduced. (auth)

1666 EXTENDED PADE METHOD AND OFF-SHELL TWO-BODY AMPLITUDE. Garibotti, C. R.; Viliani, M. (Univ., Bari, Italy). Nuovo Cim., 63A: 1267-79(Oct. 21, 1969).

An extension of the Padé method is made introducing a two-step approximant as suggested by the biorthogonal algorithm considered in a previous work. In this way a new tool is obtained for the analytic continuation of power series. The two-step approximant is particularly useful in the cases where the usual Padé method does not work, for example, the total T-matrix and the half off-shell partial-wave amplitude. The full off-shell extension of the two-body amplitude is considered and a process is developed to obtain separable forms. (auth)

1667 POLYNOMIAL BEHAVIOUR OF SCATTERING AMPLITUDES AT FIXED MOMENTUM TRANSFER IN THEORIES WITH LOCAL OBSERVABLES. Epstein, H.; Glaser, V.; Martin, A. (CERN, Geneva). Commun. Math. Phys., 13: 257-316(Sept. 10, 1969).

It is shown that, in theories of exactly localized observables, of the type proposed by Araki and Haag, the reaction amplitude for two particles giving two particles is polynomially bounded in s for fixed momentum transfer $t < 0$. The proof does not need observables localized in space-time regions of arbitrarily small volume, but uses relativistic invariance in an essential way. It is given for the case of spinless neutral particles, but is easily extendable to all cases of charge and spin. The proof can also be generalized to the case of particles described by regularized products $\int \varphi(x_1, \ldots, x_n)\, \phi_1(x - x_1) \ldots \phi_n(x - x_n)\, dx_1 \ldots dx_n$ of Wightman or Jaffe fields. (auth)

1668 ON THE ANALYTIC STRUCTURE OF PARTIAL WAVE AMPLITUDES FOR INELASTIC TWO-BODY/TWO-BODY COLLISIONS. Petersen, J. L. (NORDITA, Copenhagen). Nucl. Phys., B13: 73-107(1969).

Reduced partial wave amplitudes for inelastic processes with two incoming and two outgoing particles are examined. Areas in the s-plane where the usual projection formula gives a non-analytic result are investigated. Continuation into these areas from inside which has been touched upon already in literature is further analysed. By redefining the continuation practical rules for doing calculations are set up and found to be formally simple. Unexpected physical peculiarities are discovered, however. Instead, a continuation from outside is found to be physically more satisfactory but formally more involved although still reasonably straightforward. Details for $\bar{K}N \to \pi\Sigma$ are given. (auth)

1669 NODE-CUSP DEVELOPMENTS ON LANDAU CURVES. Cunningham, J. (University Coll. of North Wales, Bangor). Nucl. Phys., B13: 33-9(1969).

Curve tracing methods are used to demonstrate node-cusp developments on the first type leading Landau curve for the Mercedes vertex diagram. (auth)

1670 A TECHNIQUE FOR DUALISING RESONANT AMPLITUDES. Fairlie, D. B. (Univ. of Durham, Eng.). Nucl. Phys., B13: 57-67(1969).

A technique is presented for implementing the requirement of crossing symmetry and duality on an amplitude constructed from a maximal set of reasonable poles: An integral representation of the Veneziano form is found and new light is cast upon the integration parameters for the multichannel extensions of the Veneziano form. A new example of a six-point function which is constructed from resonance poles and is dual, but has a different permutation symmetry than Chan's representation, is presented. (auth)

1671 PADE APPROXIMATION AND BOUND STATES: EXPONENTIAL POTENTIAL. Basdevant, J. L. (CEN, Saclay, France. Laboratoire de Physique Theorique et Hautes Energies, Orsay, France); Lee, B. W. Nucl. Phys., B13: 182-8(1969).

The Padé approximation to the s-wave S-matrix is discussed for the exponential potential. In particular, the problem of bound states is studied in order to see how the Padé approximants approximate the analytic continuation of the S-matrix below the threshold. (L.B.S.)

1672 A DYNAMICAL CDD POLE IN THE TWO CHANNEL SCATTERING. Traenkle, E. (Freie Univ., Berlin). Z. Phys., 227: 359-76(1969). (In German).

Comparing the inelastic one channel N/D method of Frye and Warnock and the many channel matrix N/D method of Bjorken, it is shown that for a large class of many channel models the solution of the Bjorken method is a solution of the Frye-Warnock method. Using a simple model of the two channel scattering it is demonstrated that one dynamical CDD pole exists in the Frye Warnock method. (auth)

1673 CDD EFFECTS IN PARTIAL WAVE DISPERSION RELATIONS AND THE DYNAMICAL CALCULATION OF RESONANCES. Coulter, Philip W.; Shaw, Gordon L. (Univ. of California, Irvine). Symp. Theor. Phys. Math., 9: 9-19(1969).

From Symposium on Theoretical Physics and Mathematics, Madras, India. See CONF-680121.

The ambiguities due to S-matrix zeros (called CDD effects) in partial wave dispersion relations are considered for two-body elastic scattering processes. Also the $\Delta(1238)$ resonance in π + N scattering is discussed. (J.F.P.)

1674 PROPAGATORS FOR MANY-PARTICLE SYSTEMS. AN ELEMENTARY TREATMENT. Mills, Robert. New York, Gordon and Breach Science Publishers Inc., 1969. 133p.

An introduction to the field theoretic approach to the many-body problem is given. The Green function is considered which takes a variety of forms of which the general properties and relations are discussed in detail. The perturbation expansion procedure and the Feynman diagram prescription are given for the ground state and for the case of finite temperatures. Properties of these propagators are summarized, and a concise statement of the Feynman graph prescriptions developed is given. (J.F.P.)

1675 CONTRIBUTIONS FROM DAUGHTER TRAJECTORIES IN UNEQUAL MASS SCATTERING. Wang, J. M.; Wang, L. L. (CERN, Geneva). Phys. Lett., 30B: 198-201(Sept. 29, 1969).

It is shown that at $t = 0$ the asymptotic contribution from the leading daughter trajectories to certain unequal mass helicity amplitudes can be explicitly calculated using factorization properties, if the Toller quantum number M of the Regge poles requires the residue functions in these helicity amplitudes to have more zeros at $t = 0$ than required by analyticity alone. (auth)

1676 RIGOROUS DERIVATION OF GENERALIZED LIPPMANN-SCHWINGER EQUATIONS FROM TIME-DEPENDENT SCATTERING THEORY. Prugovecki, E. (Univ. of Toronto). Nuovo Cim., 63B: 569-92(Oct. 11, 1969).

The Lippmann–Schwinger equations are derived in Hilbert space from time-dependent scattering theory by introducing a suitable concept of double integration with respect to products of the spectral measures of the free and total Hamiltonian. The resulting equations hold under more general conditions than the versions which customarily occur, since they are valid even for the cases when the Hamiltonians H and H^0 are not differential operators with eigenfunction expansions. Generalizations of the usual forms of the "solutions" of the Lippmann–Schwinger equation and of the T-matrix are derived, which reduce to the conventional form when spectral expansions exist. (auth)

1677 IMPACT-PARAMETER AMPLITUDES FOR LARGE-ANGLE SCATTERINGS AND PARTICLE CORRELATIONS. Hahn, Yukap (Univ. of Connecticut, Storrs). Phys. Rev., 184: 1022-30(Aug. 20, 1969).

Impact-parameter amplitudes for potential scatterings are calculated in the various approximations, and the results are compared with the exact phase-shift analysis up to the second diffraction minimum. General trends of the approximate cross sections are given which should be taken into account in the study of correlation effect in nucleon-nucleus scattering experiments. An improved form of the amplitude for momentum transfer up to the second diffraction maximum is given. Parametrization of the nuclear correlations in terms of the two-nucleon amplitude is discussed. (auth)

1678 ON A COMPLETE ANGULAR-MOMENTUM REDUCTION OF THE FADDEEV EQUATIONS. El Baz, E.; Fayard, C.; Lamot, G. H.; Lafoucriere, J. (Univ., Lyon). Nuovo Cim., 64A: 13-35(Nov. 1, 1969).

Starting from the work of Ahmadzadeh and Tjon a complete reduction of the Faddeev equations is given. Spinless particles are first considered and the calculations are extended to any value of the total angular momentum. It is then possible to introduce the spin of the particles and following the coupling mode chosen, to find a general expression of the kernel of the Faddeev equations with interaction depending or not on the spin. Different results

mentioned previously by many authors are obtained as particular cases of our general expression. (auth)

1679 TIME-DEPENDENT APPROACH TO NONRELATIVISTIC MULTICHANNEL SCATTERING. Combes, J. M. (Centre de Physique Theorique, Marseille). Nuovo Cim., 64A: 111-44 (Nov. 1, 1969).

The mathematical problems occurring in nonrelativistic multichannel scattering theory are investigated with the help of Kato's work on the time-dependent abstract scattering theory. Emphasis is given to two-body reactions in multiparticle systems; a physically intuitive form is rigorously derived for the corresponding wave-operators and a partial asymptotic completeness is proved below the three body threshold. The relevance of the time-dependent framework is also investigated for a complete detailed study of three-particle systems. This approach also leads to some auxiliary results on multiparticle bound states. (auth)

1680 HIGHER-ORDER APPROXIMATIONS IN THE W.K.B. METHOD. Garola, C. (Univ., Turin). Nuovo Cim., 64A: 243-81(Nov. 1, 1969).

The method originally developed by Kemble and Dunham is considered to find approximate solutions to the Schrödinger equation, inside the W.K.B. method, using complex integration techniques. It is generalized in order to afford the discussion about any degree of approximation whatsoever. The method is briefly applied to scattering theory, bound states and the tunnel effect. (auth)

1681 MANDELSTAM REPRESENTATION IN POTENTIAL SCATTERING. Cheung, F. F. K. (CERN, Geneva. Eidgenoessische Technische Hochschule, Zurich). Phys. Lett., 30B: 257-9(Oct. 13, 1969).

A new simplified proof of the Mandelstam representation in potential scattering is given. It is stressed that only on the mass shell amplitudes are needed throughout the proof. (auth)

Particle Accelerators

Refer also to abstracts 51, 517, 521, 524, 1495, and 1743.

1682 (CERN-Trans-69-13) BIOLOGICAL SHIELDING AND TECHNIQUE OF RAPID EJECTION AT 70 GeV. Britvich, G. I.; Golovachik, V. T.; Krupnyi, G. I.; Lebedev, V. N.; Mal'kov, V. V.; Bushuev, N. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). Translated by A. Golovanoff (CERN, Geneva, Switzerland), from report IFVE-ORZ-69-5. 44p. (In French). Dep.

The biological shielding for a proton fast ejection system was calculated for an ejected proton beam with energy of 70 and 85 GeV and intensity of 10^{12} protons/cycle for a repetition rate of 8 cycles/min and proton efficiency of 100%. The shielding against the nuclear activity, the μ mesons, and residual activity of the target station were calculated. The arrangement of the biological shielding of the target station was discussed. (J.S.R.)

1683 (JINR-E6-4593) MAGNETIC BETA-RAY SPECTROMETER ON THE BEAM OF THE U-300 HEAVY ION CYCLOTRON. Wilhelmi, Z.; Alfeev, V. S.; Chojnacki, S.; Droste, Ch.; Lewitowicz, J.; Morek, T.; Radecki, P.; Siomin, K. I.; Srebrny, J.; Wojtasiewicz, A. W. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1969. 26p. Dep. CFSTI (U. S. Sales Only).

A toroidal beta-ray spectrometer on the beam of a heavy-ion cyclotron is described. The spectrometer together with the accompanying electronic equipment makes it possible to measure the spectra of internal conversion electrons: prompt transitions measured during the cyclotron current pulse and slow transitions (e.g., due to isomeric state decay) measured in intervals between the cyclotron current pulses. The apparatus also permits measuring the half-life $T_{\frac{1}{2}} > 1$ ms. (auth)

1684 (ORNL-tr-2239) ACTIVATION HALF-TIMES IN ACCELERATORS. Freytag, E. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Health Phys., 14: 267-9 (1968). 4p. Dep. CFSTI.

An equation by Sullivan and Overton which describes the dose rate from activation of the machine parts after shutdown of an accelerator is presented and the half time is discussed. The equation is $D(t) = B\phi \ln [(T + t)/t]$ where D(t) is dose rate, ϕ is the beam current, B takes into account the geometric and physical parameters, t is the time elapsed after turning off the machine, and T is the time of operation of the machine. (W.H.K.)

1685 (RHEL/R-181) NIMROD OPERATION AND DEVELOPMENT. Quarterly Report, January 1-March 31, 1969. Gray, D. E. (ed.) (Rutherford High Energy Lab., Chilton (England)). May 1969. 16p. Dep. CFSTI (U. S. Sales Only). UK 3s. 0d.

The Nimrod beam was on for high energy physics research for 88.76% of H.E.P. scheduled operating time. Two experiments were completed and thirteen continued through in this quarter. The dc power supplies used with beam line elements in Nimrod's experimental halls are reviewed. (auth)

1686 (RPI-328-172) RADIATION PRODUCTION AT THE RPI LINAC. Haken, J.; Ryan, R. M. (Rensselaer Polytechnic Inst., Troy, N. Y. Linear Accelerator Lab.); Moore, M. J. (General Electric Co., Schenectady, N. Y. Research and Development Center). [1969]. Contract AT(30-3)-328. 11p. (CONF-691101-1). Dep. CFSTI.

From 2nd International Conference on Accelerator Dosimetry and Experience, Stanford, Calif.

The RPI electron accelerator is a nine section traveling wave linac operating at L-Band. Power output is over 50 kW in the 50-70 MeV range. The accelerator has been operated for over nine years and is primarily used as a source of neutrons in reactor design measurements. Electron pulses from 4.5 μsec to 10 ns width may be produced in single shots and at repetition rates ranging to 720 pps. The accelerator is typically operated at 60 MeV with 25 kW average beam power. Peak dose distributions for single 1 μsec pulses at 50 MeV were measured with LiF TLD's placed directly in the electron beam. Electron isodose curves for short bursts at various dose rates were also obtained. Peak e- doses were found to approach 4×10^9 rad/sec at 25 cm from the beam output window. Gamma doses produced by a 1 μsec electron pulse striking a thick ^{238}U converter were determined using a $\frac{1}{8}$-in. lead shield to allow the TLD's to attain electronic equilibrium. A study was made of relative thermal neutron production for various operating conditions over the range of 40-60 MeV. The neutrons were produced in a thick water cooled tantalum target with a 4×4 inch polyethylene-cadmium sandwich as a moderator. The thermalized neutrons were collimated to 1 in.^{2} and counted with a ^{10}B enriched BF_3 beam monitor detector. The data indicate that over this energy range neutron production is a linear function. (auth)

1687 (SJC-A-68-1) THEORY OF FIELD STRENGTH DETERMINATION IN RF STRUCTURES BY PERTURBATION TECHNIQUES. Nakamura, M. (Tokyo Univ. (Japan). Inst. for Nuclear Study). Feb. 1968. 44p. Dep. CFSTI (U. S. Sales Only).

A method for determining electric and magnetic fields in both resonant and non-resonant rf structures using perturbation techniques based on the reciprocity principle is presented. Form factors of various perturbing objects are discussed, and form factors of an ellipsoid are derived. Also, a perturbation formula for slight deformation of conducting or insulating walls is developed. These field strength determinations are necessary to accurately evaluate the beam performance of a traveling-wave linear accelerator or an rf particle separator or tube. The theory is presented assuming isotropic media. (W.H.K.)

1688 (SJC-A-68-2) HAMILTONIAN FORMULATION OF NON-LINEAR BETATRON OSCILLATIONS IN A BEAM EJECTION SYSTEM OF AN AG SYNCHROTRON. Huke, Kazuo (Tokyo Univ. (Japan). Inst. for Nuclear Study). Mar. 1968. 7p. Dep. CFSTI (U. S. Sales Only).

A time averaged Hamiltonian in a certain period is deduced from the motion of a non-linear betatron oscillation excited by many multipole magnets which are used in a resonant beam ejection system of an alternating-gradient synchrotron. (W.H.K.)

1689 (SJC-A-68-4) MEASUREMENTS ON THE MAGNETIC PROPERTIES OF FERRITE CORES FOR PROTON SYNCHROTON RF ACCELERATING CAVITY. Kamei, T.; Kondo, M.; Yamaguchi, T. (Tokyo Univ. (Japan). Inst. for Nuclear Study). Sept. 1968. 19p. Dep. CFSTI (U. S. Sales Only).

Ferrite cores are used for tuning the rf accelerating cavity of proton synchrotrons. Since most of the rf power is lost in the ferrite, the performance of a cavity as the load of an rf amplifier mainly depends on the qualities of the ferrite cores loaded in it. Accurate measurements and selection of favorable ferrite material for the accelerating cavity are quite essential to the design study of the rf system. Two coaxial cavities, designed to test individual ferrite cores under the same condition as in the accelerating cavity, were constructed; and an apparatus using a Q-meter to detect local inhomogeneities of magnetic properties in a large ring is described. Measurements of the incremental permeability and the quality factor of ferrite cores are discussed. (W.H.K.)

1690 (SJC-A-68-5) STUDY OF THE POLE SHAPE OF GRADIENT MAGNET FOR A STRONG FOCUSING SYNCHROTRON. Kihara, Motohiro; Doke, Tadayoshi (Tokyo Univ. (Ja-

pan). Inst. for Nuclear Study). Oct. 1968. 40p. Dep. CFSTI (U. S. Sales Only).

The possibility of improving the high field quality of the strong focusing synchrotron magnet by suitable choice of the pole shape is investigated by computer calculation. It is shown that there is an optimum pole shape on the high field side for a given pole width. With the optimum pole shape the sextupole and octupole components of the field strength can be made appreciably small. Also, by using the results of the calculation, the approximate design of the synchrotron magnet is described. (auth)

1691 (SJC-A-68-6) INVESTIGATION OF MAGNET STEELS FOR PROTON SYNCHROTRON. Masuda, Masayoshi; Doke, Tadayoshi (Tokyo Univ. (Japan). Inst. for Nuclear Study). Dec. 1968. 21p. Dep. CFSTI (U. S. Sales Only).

Results of an investigation of the properties of various types of steel for use in proton synchrotron magnets are presented. Magnetic and mechanical properties of rimmed steel, silicon killed steel, aluminum killed steel, phosphor additive rimmed steel, and oriented soft iron were studied. (W.H.K.)

1692 (SJC-A-69-1) ACHROMATIC BEAM TRANSPORT SYSTEMS USING AN ELECTRIC FIELD AND A MAGNETIC FIELD. Takeda, Tatsuoki; Arikawa, Tatsuo (Tokyo Univ. (Japan). Inst. for Nuclear Study). Mar. 1969. 19p. Dep. CFSTI (U. S. Sales Only).

Achromatic beam transport systems using an electric field and a magnetic field are studied. It is concluded that a quadrupole lens, a bending magnet and a DC separator can be made achromatic or dispersionless, especially for low or intermediate momentum particles by this method. (auth)

1693 (SJC-A-69-3) MAGNETIC FIELD MEASUREMENTS OF MODEL MAGNET (MARK I) FOR 40 GeV PROTON SYNCHROTRON. Hirose, Tachishige; Sasaki, Hiroshi (Tokyo Univ. (Japan). Inst. for Nuclear Study). June 1969. 40p. Dep. CFSTI (U. S. Sales Only).

Apparatus have been developed for the dynamic measurements on the magnetic characteristics of a model magnet (Mark I) for the 40 GeV proton synchrotron. To investigate the effects of permeability, eddy currents, tolerances of the gap height and so on, the field gradient is required to be measured to an overall accuracy of an order of 0.1%. For this purpose, the magnetic induction method, employing a digital and an analogue integrator for the measurements of the magnetic field above several hundred gauss, was selected. For lower fields around the injection field, 140 gauss, the relevant method of a peaking strip was developed. Descriptions of the principle of the measurements are given, and the equipment used for the measurements of the dynamic field above several hundred gauss is described. Results of the measurements on the model magnet Mark I are presented. (W.H.K.)

1694 (SJC-A-69-5) FIELD CALCULATIONS AND DISPERSION CURVES FOR PERIODICALLY LOADED STRUCTURES. Gluckstern, R. L. (Tokyo Univ. (Japan). Inst. for Nuclear Study). July 1969. 22p. Dep. CFSTI (U. S. Sales Only).

The complete analytical solutions for special models of periodic structures are formulated, and these solutions are correlated with structure compensation. A waveguide in which only one mode propagates, and in which the periodic perturbations are sufficiently far apart to neglect the interaction between them in all but the accelerating mode, is studied. A rectangular waveguide with periodic narrow posts extending part way across the aperture is considered. Also, a waveguide of arbitrary cross section loaded by periodic thin fins extending part of the way across the aperture is considered. In each case, general statements are made relating the dispersion curve to structure compensation. (W.H.K.)

1695 (TRI-68-9) MAGNET SYSTEMS FOR THE TRANSPORT OF ION BEAMS WITH NO CHANGE OF PROPERTIES. Tautz, Maurice F. (TRI - Univ. Meson Facility, Vancouver (British Columbia)). Oct. 1968. 35p. Dep. CFSTI (U. S. Sales Only).

The matrix formalism method for describing particle motion through a beam transport system is reviewed. Thick lens quadrupole identity sections for which the system transformation matrix in both xz and yz planes satisfies $T = \pm I$, where I is the unit matrix, are investigated for four quadrupole systems, a minimum gradient system and an infinite periodic system. Also, recovery of the thin lens formula as L approaches zero, and acceptance calculations for thick lens identity sections are described. (W.H.K.)

1696 (UCRL-18896) ERA DEVELOPMENT AT BERKELEY. Keefe, Denis (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 26, 1969. Contract W-7405-eng-48. 21p. (CONF-690811-11). Dep. CFSTI.

From 7th International Conference on High Energy Accelerators, Moscow, USSR.

Progress on the development of an electron-ring accelerator at Berkeley is described. Design parameters are discussed, and results of experiments with Compressor III using the Astron linear induction electron accelerator are presented. Ring formation, compression, extraction, and acceleration are considered. (W.H.K.)

1697 (UCRL-19304) ABSOLUTE CONTAINMENT OF A KILOCURIE ^{3}H TARGET AT A LOW ENERGY RESEARCH ACCELERATOR. Aune, Raymond G. (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1969. Contract W-7405-eng-48. 11p. (CONF-691101-2). Dep. CFSTI.

From 2nd International Conference on Accelerator Dosimetry and Experience, Stanford, Calif.

Requests are frequently made for the use of tritium targets in particle accelerators for the production of 14-MeV neutrons. Titanium tritide targets are commonly used, and publications presently available describe the techniques and handling of these targets. In our case, however, the experiment called for a gaseous tritium target containing several hundred curies that could be bombarded by a deuteron beam from the 88-inch cyclotron without accelerator contamination or personnel exposure. The problems and hazards associated with the use of these ^{3}H targets were investigated. Particular emphasis is placed on the use of high-speed vacuum valves activated by explosive squibs that receive their signal from a mass spectrometer; also, absorption pumps were used in order to have a complete closed pumping system. A potential contamination problem existed due to the extremely thin windows of the ^{3}H cell, the pressure differential between the cell and the surrounding scattering chamber, and possible sudden loss of the cyclotron vacuum. Contamination in the cyclotron would interfere with beam development work and activities of the maintenance crew. The target cave area and the building itself are not equipped with ventilation appropriate to large quantities of radioactive gas. In addition, because of several factors, the release of tritium cannot be precisely measured. The behavior of tritium in the environment is not completely understood. The policy of this Laboratory is not to dilute and disperse but to "concentrate and confine," and means of preventing tritium release were necessary. The study led to the development of a long-needed fast-acting vacuum valve that could be used in the field of nuclear research. The criteria for such a valve were: Fast enough closing to stop the diffusion of the gas into the cyclotron after some sort of signal to the closing mechanism; a high degree of reliability; a large enough diameter to allow the beam to go through; and simplicity of operation and maintenance. Commercial explosives in the form of squibs were chosen as the source of power for the valves because of their very high degree of reliability, the reproducibility of the force created by the explosion, and their compatibility with electronic firing mechanisms. The combination of proper materials and the very high energy available from the squibs made these valves extremely positive and reliable. Even slight misfits and misalignments are overcome by the great closing force. Two ion gauges were used to produce a signal for the explosive squibs. One, in the rf chamber, detected a pressure increase on the cyclotron, the second, on the scattering chamber, detected an increase of pressure that perhaps was due to a leak in the ^{3}H cell. Since speed was of great importance in the closing of the valves, a mass spectrometer, which is more sensitive than an ion gauge, was installed in the scattering chamber to detect minute quantities of gas that might appear. Both ion gauges and the mass spectrometer were connected to a specially designed triggering device that would produce a signal for the explosive squibs. To prevent any release of ^{3}H into the building or the environment, a complete closed pumping system was provided by two absorption pumps. The pumps were also used to empty the ^{3}H cell upon completion of the bombardment. With this new approach to the problem one can run gaseous tritium targets of thousands of curies relatively safely on the cyclotron. In addition, the system can very simply be incorporated to handle the bombardment of any radioactive target. (auth)

1698 THE ACCELERATION OF PARTICLES BY COLLECTIVE FIELDS. I. Sessler, Andrew M. (Univ. of California, Berkeley). Comments Nucl. Particle Phys., 3: 93-100(July-Aug. 1969).

The present activity and current status of electron-ring accelerator research is described. These accelerators and the behavior of the beams they produce are discussed. The experimental demonstration that large accelerating fields can arise from collective behavior is reviewed. (J.F.P.)

1699 COLLECTIVE LINEAR ACCELERATION OF IONS AND CLASSICAL PRINCIPLES OF ACCELERATION. Enchevich, Ivan. Fiz.-Mat. Spis., Bulg. Akad. Nauk, 12: 22-7(1969). (In Bulgarian).

A survey of ion acceleration methods and principles starting with equations determining the operation of betatrons and ending with a brief report concerning the projected 1,000 GeV Soviet accelerator with a 10^{13} protons/cycle yield is presented. (JPRS)

1700 IMPROVEMENTS IN OR RELATING TO ACCELERATORS FOR CHARGED PARTICLES. Russell, Francis Michael (to Science Research Council). British Patent 1,165,181. Sept. 24, 1969. Filed Jan. 6, 1967.

Reference is made to accelerators for charged particles, and more particularly to separated-orbit cyclotrons. Normally the rf energy to excite the cavities is provided by a thermionic valve power amplifier and is supplied to the cavities over transmission lines, but the efficiency with which such amplifiers generate the required large quantities of rf power is not very great. The accelerator described comprises at least one electrically resonant cavity for providing an electric field to react with the beam of charged particles, an electron beam source for producing a pulsed beam of high energy electrons, means for guiding the electron beam so that it passes through the cavities in such a phase relationship with the beam of charged particles that power is coupled from the electron beam to the cavities so that the charged particles are accelerated; the electron beam energy and the action of the guide are such that the electron beam path is spaced from the path limits of the beam of charged particles. The separated orbit cyclotron described comprises a series of magnets and cavities disposed in a closed ring, and a beam tube within which a pulsed beam of charged particles is focused, accelerated, and confined by the magnetic and electric fields; the beam follows a spiral path whose radius increases as the energy of the charged particles increases. The action of the associated electron beam is as already described. The energy of the electrons is such that they circulate in an orbit outside the outermost turn of the spiral path followed by the beam of charged particles. Alternative designs of cavity and magnet systems are described. Means may be provided between adjacent pairs of cavities to reduce the energy dispersion of the electron pulses; these means may comprise cavity resonators through which the electron beam passes, each such cavity resonator being excited at a high harmonic of the frequency of the electric field associated with the cavities. More than one electron beam may be provided, these beams entering the cyclotron at symmetrically disposed points around the periphery, and each electron beam passing through a number of consecutive cavities before being diverted out of the cyclotron at a point in the periphery just before the point where the next electron beam enters. The electron beam source, together with the associated modulator, high voltage generator, and linear accelerator, are also described. (UK)

1701 ACCELERATING STRUCTURE FOR THE PROTON LINEAR ACCELERATOR FOR HIGH ENERGIES. Andreev, V. G. Zh. Tekh. Fiz., 38: 1306-16(Aug. 1968). (In Russian).

The wave equation for cylindrical resonator loaded at equal intervals with conducting rings and excited in the TM mode was resolved. The wave equation indicated the bond between the wave resonance length and the geometrical dimensions of the resonator. An efficient installation shows that metallic bars should be used to support the conducting rings. High-frequency losses were also calculated. The drift time and effective shunting resistance were determined. Compensations for resonance shifting due to the metallic bars were resolved by increasing the diameter of conductance rings. The simple construction, cylindrical volume of the resonator with conducting rings excited in the TM_{02n} mode proved to be a promising acceleration structure for high-energy proton linear accelerators. (R.V.J.)

1702 HARMONIC COMPOSITION OF A CURRENT IN A RESONANT BUNCHER TAKING INTO ACCOUNT THE SPACE CHARGE. Snedkov, B. A.; Galkov, V. A. (All-Union Correspondence Inst. of Power Engineering, Moscow). Zh. Tekh. Fiz., 38: 1317-19(Aug. 1968). (In Russian).

Resonant buncher used in accelerators and klystron-type installations was studied in order to determine the efficient parameters of bunching and harmonic current composition important for calculating optimum operating conditions of the installations. The method of calculations used by B. A. Snedkov (Zh. Tekh. Fiz. 25, 2, 282(1965)) for resolving electrodynamic problems, which found the extent of the bunch, energy distribution of particles in the bunch as a function of drift, modulation amplitude, and beam current was used for carrying out harmonic analysis of current pulses in the resonant bunches. Tabulated results of calculations revealed a mean 15% the difference between obtained results and published data. Moreover, the kinematic calculations are even less accurate for high harmonic numbers. The amplitudes of the highest harmonics drop sharply with increased volume charge density. (R.V.J.)

1703 INCREASED CHARGE DENSITY IN THE ELECTRON BEAM. Zinchenko, N. S. (Kharkov Inst. of Radiophysics and Electronics). Zh. Tekh. Fiz., 38: 1344-6(Aug. 1968). (In Russian).

A method is described for increasing the charge density of electron beams by means of a tri-electrode gun with longitudinal compensation. The principal function for electron charge densities in the beam at the gun outlet, and the magnitudes of density (~10^{10} to 10^{11} e^-/cm^3) were obtained. (tr-auth)

1704 COLLIMATING OF THE INNER ELECTRON BEAM IN BETATRON. Korobochko, Yu. S.; Mineev, V. I.; Petrochenko, A. F. (Leningrad Polytechnic Inst.). Zh. Tekh. Fiz., 38: 1387-9(Aug. 1968). (In Russian).

It was found that collimation of internal electron beam in a betatron by means of shutters produced in a target a focal spot of 1.5×0.2 mm^2. The effective distribution of angular straggling of electrons entering into the target at E = 15 MeV was reduced by the order of 0.1. (tr-auth)

1705 HELIUM REFRIGERATION SYSTEM FOR A 100-GeV SUPERCONDUCTING ACCELERATOR. Ratliff, G. (Stanford Linear Accelerator Center, Calif.). Cryog. Ind. Gases, 4: No. 10, 29-33(Oct. 1969).

The helium refrigeration system for the proposed 100-GeV superconducting linear accelerator program at SLAC is discussed. The system required would have a cooling capacity of approximately 14.2 kW at operating conditions of 1.85°K and 14.82 torr. Approximately 450,000 liters of liquid helium will be required to fill the dewars. The refrigeration system currently under consideration is based on a two-expansion Cloude cycle providing two stages of isobaric refrigeration at 60 to 70°K and 10 to 15°K temperature levels for a Linde–Hampson cycle to furnish refrigeration at 1.85°K. (B.G.D.)

1706 DYNAMICS OF PARTICLES IN THE INJECTOR ACCELERATOR WITH THE WAVEGUIDE PREBUNCHER. Ostrovskii, E. K.; Vishnyakov, V. A.; Makarov, A. F. (Kharkov Inst. of Physics and Tech.). Zh. Tekh. Fiz., 38: 1299-1305(Aug. 1968). (In Russian).

The injector system for an electron accelerator with a waveguide prebuncher was studied and an optimum variation of bunching was selected using the complete equation system for particle motion. The beam focusing problems for the examined system were analyzed and it was shown that special compensating windings were necessary along the accelerator in order to counteract the transverse geomagnetic field which distorted the structure of the beam. (R.V.J.)

1707 HIGH POWER ELECTRON ACCELERATOR "HYPERTRON 30". Arakawa, Kazuo; Shimizu, Yasuhiro (Matsushita Electric Industrial Co., Osaka). Nat. Tech. Rep. (Matsushita Elec. Ind. Co., Osaka), 15: 443-50(Aug. 1969). (In Japanese).

The HYPERTRON 30, 300 keV, 30 mA low energy and high power electron accelerator, developed for electron beam curing purposes is described. The construction, function and the characteristic features of this accelerator are briefly reported. Moreover, as a result of the measurement of the characteristics of low energy electron beams irradiated from this accelerator, it was found that depth dose curves for low energy electron beams are different from those for high energy ones. Also, the influence of back scattered electrons on depth dose curves was studied, and it was seen that irradiation window loss counted a good deal (measured to be 27%). A brief discussion on electron beam curing processes was also carried out. (auth) (NSA of Japan)

1708 POSSIBLE MODE OF ACCELERATING AND PRODUCING A BEAM IN A ISOCHRONOUS CYCLOTRON. Basargin, Yu. G.; Litunovskii, R. N. Dokl. Akad. Nauk SSSR, 186: 1288-90(June 21, (1969). (In Russian).

Improving the monoenergetic quality of a cyclotron beam can be attained by using the analyzing properties of the cyclotron magnetic field near the exit at a radius close to the edge of the radial stability. The limitations of the usual accelerating system can be overcome by using a double accelerating system with two dees. The main dee operates at a frequency close to the rotational ion frequency, while the other dee operates at triple this frequency. Both dees are connected in phase. Injection takes place into the main dee with subsequent isochronous acceleration. Then the beam is bunched by creating a positive perturbation shifting the phase zone by 55° to the left. Then the bunched beam is again accelerated isochronously at a large increase in energy per revolution. At the end of the acceleration there is a sharp drop in magnetic field shifting the phase region to the right. Debunching of the beam takes place now. Ions are withdrawn at a small increase in energy per revolution. For an energy dispersion in the withdrawn

beam of 3×10^{-4} it is found that the allowable width of the starting phase region is 37° and not 2.5°, as is required with the usual accelerating system. This system can be modified for use in isochronous cyclotrons having a magnetic system consisting of separate blocks. (TTT)

1709 BEAM-SHAPING SYSTEM FOR A 2-GeV ELECTRON ACCELERATOR. Grishaev, I. A.; Kovalenko, N. A.; Kolosov, V. I.; Petrenko, V. V. (Engineering-Physics Inst., Kharkov). Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 139-42(July 1969).

Translated from Zh. Tekh. Fiz., 39: 197-202(Jan. 1969).

Beam shaping at the output of a linear accelerator that accelerates electrons to an energy of 2 GeV is discussed. A description is given of the individual sections and elements of the shaping system. Methods are described for adjusting the system and its individual elements. The characteristics of the beam of accelerated electrons at the accelerator output and at the target are given. (auth)

1710 METHOD OF PRODUCING A BETATRON FIELD. Vaisburd, I. M. (Ural Polytechnic Inst., Sverdlovsk, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 143-7(July 1969).

Translated from Zh. Tekh. Fiz., 39: 203-8(Jan. 1969).

The problem of producing a betatron field from an axially symmetric system of currents is considered. Methods are given for determining the profiles of the pole faces of the electromagnets which provide a field of the required form. A betatron field is formed from elementary circular currents, and the profiles of the pole faces of the electromagnets are given. (auth)

1711 POSSIBLE INCREASE IN MAXIMUM CURRENT IN A TRAVELING-WAVE LINEAR ACCELERATOR. Vishnyakov, V. A.; Grishaev, I. A.; Grizhko, V. M.; Zykov, A. I.; Makhnenko, L. A. (Physical-Technical Inst., Kharkov). Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 231-4(Aug. 1969).

Translated from Zh. Tekh. Fiz., 39: 321-5(Feb. 1969).

The maximum value of the current in linear accelerators is limited by the onset of beam breakup because of the excitation of hybrid EH_{11} modes. In multisection accelerators, this phenomenon is particularly strong because the transverse modulation of the beam in the initial sections at low electron energy leads to a sharp rise in the power level of the hybrid modes along the length of the accelerator. It is shown experimentally that the pulse value of the current in an accelerator can be increased significantly either by the replacement of one or several of the first sections in the accelerating structure by ones in which the frequency of the hybrid HEM_{11} modes differs from the corresponding frequency in the main sections by 30 to 50 MHz or by breaking up a long, iris-loaded wave guide into short subsections with filters for hybrid HEM_{11} modes between them. (auth)

1712 PHASE STABILITY OF AN INTENSE BEAM IN A RELATIVISTIC STORAGE RING. Karliner, M. M.; Ostreiko, G. N.; Shekhtman, I. A. (Inst. of Nuclear Physics, Novosibirsk, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 235-40 (Aug. 1969).

Translated from Zh. Tekh. Fiz., 39: 326-33(Feb. 1969).

Phase stability in the motion of relativistic particles in a storage ring is discussed taking account of the voltage induced in the high-frequency accelerating system by particle bunches. It is found that limitations are imposed on the beam current by the condition of phase equilibrium. An optimum resonator design is found which will provide the maximum number of particles for given high-frequency generator parameters. The conditions for matching the resonator with the high-frequency generator are found. (auth)

1713 THEORY OF WEAK LENSES IN ELECTRON OPTICS. Ovsyannikova, L. P.; Yavor, S. Ya. Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 304-5(Aug. 1969).

Translated from Zh. Tekh. Fiz., 39: 412-14(Feb. 1969).

Conditions for which the paraxial equations of electron optics for weak lenses remain valid even for off-axis trajectories are examined. The quadrupole lens is studied as a specific example. (auth)

1714 CALIBRATION OF TRACKING ELECTRODES IN PROTON SYNCHROTRONS. Kazanskii, G. S.; Mikhailov, A. I.; Tsarenkov, A. P.; Chekhlov, K. V. Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 363-8(Sept. 1969).

Translated from Zh. Tekh. Fiz., 39: 492-9(Mar. 1969).

A method for measuring the effective length of tracking electrodes by means of a free-falling charged sphere is discussed. The measurement process reduces to determining the ratio of the integral of the charge induced on the electrodes (integrated with respect to the coordinate of motion) to the total charge on the sphere. An analytical solution for the problem posed for the case of the simplest tracking electrode design is given, and a detailed description of the experimental equipment and measurement procedures is presented. (auth)

1715 MEASUREMENT OF CHARGE PHASE DISTRIBUTION IN A TRAVELING-WAVE LINEAR ACCELERATOR. Ivanov, G. M.; Pilipenko, V. V.; Makhnenko, L. A.; Dovbnya, A. N. (Physical-Technical Inst., Kharkov). Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 369-73(Sept. 1969).

Translated from Zh. Tekh. Fiz., 39: 500-5(Mar. 1969).

Data are given on the structure of the bunches in the 360-MeV linear electron accelerator at the Physicotechnical Institute, Academy of Sciences, Ukrainian SSR. In addition, the dependence of the output phase of the bunches on the principal parameters of the injector was measured. The calculations were carried out on a Minsk-2 electronic computer. The error in calculating the phase was less than ±1.5°. (auth)

1716 HIGH-CURRENT ELECTRON BEAM IN A LINEAR INDUCTION ACCELERATOR. Vakhrushin, Yu. P.; Kuznetsov, V. S. Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 374-8(Sept. 1969).

Translated from Zh. Tekh. Fiz., 39: 506-12(Mar. 1969).

It is noted that it is convenient to use a longitudinal magnetic field to produce a high-current beam in a linear accelerator. An equation is derived determining the shape of the accelerated electron beam in the longitudinal magnetic field for zero magnetic field at the cathode. A solution to this equation is given for cases in which the focusing magnetic field is constant along the accelerator axis (B = const) and when it is inversely proportional to the square root of the particle momentum ($B \sim 1/\sqrt{p}$). It is shown that when B = const the beam equilibrium radius decreases in proportion to the acceleration and the oscillation amplitude remains constant. When $B \sim 1/\sqrt{p}$, the equilibrium radius remains constant but the oscillation amplitude increases in proportion to the increase in beam energy. (auth)

1717 MAGNETO-OPTICAL SYSTEMS WITH A PLANE OF SYMMETRY. Basargin, Yu. G. Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 171-5(Aug. 1969).

Translated from Zh. Tekh. Fiz., 39: 241-8(Feb. 1969).

The motion of a beam of particles that is discontinuous in time is described in the median plane of an optical system, using four-dimensional transformation matrices which take into account the connection between the transverse motion and the longitudinal motion. The effect of a momentum spread on the value of the effective transverse emittance of the beam under different initial conditions is considered. It is shown that the resolving power in systems with momentum analysis is directly related to debunching of the beam. Conditions are formulated for the realization of undispersed, achromatic, and isochronic magneto-optical systems. (auth)

1718 THEORY OF A LINEAR INDUCTION ACCELERATOR. Matora, I. M. Sov. Phys.-Tech. Phys. (Engl. Transl.), 14: 134-8 (July 1969).

Translated from Zh. Tekh. Fiz., 39: 190-6(Jan. 1969).

The paper presents (1) a differential equation, similar to the Biot–Savart law, for calculating the induction electric field and (2) a relativistic generalization of the equation for the paraxial trajectories of electrons in a strong, axially symmetric electric field. Other equations required for designing a linear induction accelerator are given. The possibility of accelerating heavy charges in a linear induction accelerator is discussed. (auth)

1719 INTERACTION OF CYCLOTRON WAVES IN ELECTRON BEAM WITH TRAVELING ELECTROMAGNETIC WAVES. Barybin, A. A.; Gorin, Yu. N. Radiotekh. Elektron., 14: 1257-63(July 1969). (In Russian).

The effects of distributed losses in the slowing down system on the interaction of cyclotron and electromagnetic waves were studied theoretically and confirmed experimentally. In relation to the ratio of the coefficient of the coupling and the coefficient of the damping exist three regimes of interaction of the cyclotron wave and the electromagnetic wave including periodic, critical, and aperiodic. (tr-auth)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 50–52, 55–57, 497, 1485, and 1740.

1720 (AECL-3255) A STUDY OF THE ACCURACY OF g-FACTORS FOR ROOM-TEMPERATURE MAXWELLIAN SPECTRA FOR U AND Pu ISOTOPES. Westcott, C. H. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Apr. 1969. 113p. Dep. CFSTI (U. S. Sales Only). CAN $2.50.

At this time, when the 2200 m/sec values of the neutron cross sections and other constants of fissile nuclei are again under review, it is important to have up-to-date values of the g-factors for these nuclei and particularly to have reliable estimates of their accuracy. This is because the g-factors which arise in interpreting measurements of data made in Maxwellian neutron spectra, or reactor spectra approximating thereto, affect many of the values which form the basis of a regression analysis, and the relative weights given to different values depend directly on accuracy estimates. A detailed study is presented of the possible changes in the shapes of curves of variation of the cross sections with neutron energy, based on the measured values used to fix these curves, and which complements a study on a more theoretical basis by E. Vogt et al. (unpublished). The accuracies of the room-temperature g-factors for ^{239}Pu, ^{233}U, and ^{235}U were determined. A less complete study of this problem for ^{241}Pu is also described. (auth)

1721 (RPI-328-162) LINEAR ACCELERATOR PROJECT. Progress Report, April 1–June 30, 1969. (Rensselaer Polytechnic Inst., Troy, N. Y.). Contract AT(30-3)-328. 103p. Dep. CFSTI.

IRON — neutron age in, fast, (E)
IRON-56 — neutron capture by, temperature dependence of 1.15 keV resonance in, (E)
NICKEL-60 — neutron capture at intermediate energies, resonance energies and yields for, (E)
PLUTONIUM-239 — neutron capture to fission ratios at 0.2 to 25 keV, (E)
PLUTONIUM-240 — neutron absorption at 0.7 to 100 keV, activity from, (E)
VANADIUM-51 — neutron capture at intermediate energies, resonance energies and yields for, (E)
VANADIUM-51 — neutron total cross section at 2 to 18 keV, multilevel fit to, (T) (J.W.R.)

1722 CALCULATION OF THERMALIZATION OF PULSED NEUTRONS BY FEW-POLE EXPANSION METHOD. Hoshino, Tsutomu (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo), 6: 514-21(Sept. 1969).

The thermalization of pulsed neutrons was numerically calculated with the few-pole expansion method, which gives an approximate solution in the form of a superposition of pseudo modes (functions of energy) with pseudo decay constants (also functions of energy). The time dependent neutron flux, the Cd and Gd γ-activation responses, as well as the neutron temperature in a pulsed water assembly were obtained as examples, and the results compared with experimental data, with calculations by direct time integration method, and with calculated time eigenvalues of the medium. These examples attest to the efficacy of the few-pole expansion method, the adoption of only three pseudo modes having yielded accurate numerical solutions, with only a small fraction of the computing time required by other methods such as direct time integration. (auth)

1723 SPECTRAL INDICES OF AN INTERMEDIATE ENERGY NEUTRON SYSTEM. Inoue, Kazuhiko; Kanda, Keiji; Nanjyo, Tsutomu. Annu. Rep. Res. Reactor Inst., Kyoto Univ., 1: 241-5 (Oct. 1968).

The neutron spectrum of an intermediate system was studied by means of the spectral indices. The spectrum was characterized by the energy value of the spectral peak, and the mean or median energy of neutron absorption. Three spectral indices were introduced, in which one index was a differential one and the others were integral indices. These indices were described in the term of competition of the neutron absorption and the slowing down power. In the case of a hypothetical absorption cross section of $1/v$, all the indices were calculated and were found to be almost proportional to $E^{\frac{1}{4}}$. As for ^{235}U, ^{233}U, and a hypothetical absorption cross section of $E^{-\frac{1}{2}}$, the spectral indices were also calculated. A simple estimation of the energy value of the spectral peak was made for the system with neutron leakage. (auth)

1724 THE BEHAVIOR OF ONE-VELOCITY NEUTRONS IN INFINITE MEDIUM. Beauwens, Robert; Mika, Janusz (Inst. of Nuclear Research, Swierk, Poland). Nukleonika, 14: 461-73 (1969).

The time behavior of neutrons is closely related to the spectrum of the transport operator. It is shown that in case of one-velocity neutrons in an infinite medium the spectrum of transport operator consists of an infinite line, parallel to the imaginary axis and of a finite interval of the real axis. With the use of the Fourier transform technique the explicit expression for the resolvent operator and to the solution of the initial value problem is given. The results obtained allow calculation of the Green's function in an infinite medium, a necessary preliminary step in extending the boundary sources method to the time dependent problem. (auth)

1725 IMITATION OF A FISSION NEUTRON SPECTRUM BY MEANS OF A POLONIUM–BERYLLIUM SOURCE. Kryzhanovskii, V. A.; Terekhin, V. A. At. Energ. (USSR), 27: 157-8(Aug. 1969). (In Russian).

A fission neutron spectrum was imitated by placing a Po–Be source in a sphere of graphite or iron. The sharp change in the form of the neutron energy distribution takes place as a result of elastic scattering on carbon, and of inelastic scattering of neutrons on iron. Measurements carried out on a single-crystal scintillation spectrometer (stilbene 30 × 25 mm) showed that a fission neutron spectrum can be satisfactorily imitated by placing a Po–Be source in an iron sphere having a diameter of 400 mm. The errors in measuring the neutron energy distributions were 10 to 20%. (auth)

1726 SLOW NEUTRON SCATTERING ON MONOATOMIC FLUIDS. Khrushchev, B. I. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 3, 66-70(1969). (In Russian).

Scattering of slow neutrons on a model of a monoatomic fluid was studied, considering that the liquid consists of ordered regions in which the mean positions in the crystalline lattice are presented as a combination of harmonic oscillators. The amplitude of shifting of one atom in relation to the other is taken to be proportional to the distance between them and can be expressed by superposition of normal longitudinal oscillations. The diffusing motion in the model was not considered. The studies were confined to the coherent scattering on heavy spin-free nuclei of one isotope. (R.V.J.)

1727 OBSERVATION OF ULTRACOLD NEUTRONS. Lushchikov, V. I.; Pokotilovskii, Yu. N.; Strelkov, A. V.; Shapiro, F. L. (Joint Inst. for Nuclear Research, Dubna, USSR). JETP Lett. (USSR) (Engl. Transl.), 9: 23-6(Jan. 5, 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu, 9: 40-5(Jan. 5, 1969).

Since it was previously noted that the idea of storing neutrons suggests a way of increasing the accuracy of measuring the neutron dipole moment, which is important in the CP violation problem, the feasibility of extracting and retaining ultracold neutrons is experimentally checked. It is found that the ultracold neutrons are produced and propagate in accordance with theoretical expectations. (J.F.P.)

1728 A QUANTAL APPROACH TO THE PROBLEM OF NEUTRON MULTIPLE SCATTERING IN A SLAB. Kalashnikov, N. P.; Longo, G. (Comitato Nazionale Energia Nucleare, Bologna). J. Nucl. Sci. Technol. (Tokyo), 6: 536-9(Sept. 1969).

The solution of a neutron multiple scattering problem is obtained by using a quantal approach. The elastic isotropic scattering is considered in the approximation where the scattering length is much less than both the neutron mean free path and the average distance between nuclei. In the case of a finite thickness slab, the probability density of the neutron momenta as a function of the traversed depth and of the scattering cosine is written directly in quadratures without using the transport equation. (auth)

1729 ANISOTROPIC MULITGROUP TRANSPORT THEORY. Shultis, J. Kenneth (Univ. of Groningen, Netherlands). Nucl. Sci. Eng., 38: 83-93(Nov. 1969).

A method for solving various infinite medium and half-space multigroup transport problems with anisotropic transfer is presented. A set of eigensolutions for the homogeneous multigroup equations is obtained and is shown to have "full-range" completeness and orthogonality properties. These properties then can be used to solve for the infinite medium Green's function. Half-space problems are solved in two distinct steps. First, the emergent distribution is calculated. Then, application of the full-range

completeness property gives the complete solution everywhere in the half-space. The success of this method implies that the eigensolutions also possess a "half-range" completeness property. (auth)

1730 PRODUCTION OF COLD NEUTRONS. Sahabettin, Ergenc (to Sulzer Brothers Ltd.). U. S. Patent 3,470,065. Priority date July 5, 1965, Switzerland.

Cold neutrons are produced from the fission neutrons of a nuclear reactor in the moderator with the aid of liquefied hydrogen deuteride circulated through a chamber in the moderator, the liquefied gas being obtained by compressing hydrogen or hydrogen deuteride gas, cooling and liquefying the compressed gas by countercurrent heat exchange flow with previously compressed and subsequently expanded gas, supercooling the condensed gas by evaporation of a fraction thereof expanded to intermediate pressure, passing the liquefied supercooled gas through a chamber in the moderator of the reactor, evaporating and superheating the liquefied gas emerging from the chamber by passing it in countercurrent heat exchange flow with newly compressed gas, expanding with performance of external work the evaporated and superheated gas and combining it with that fraction as evaporated in the supercooling step and further heating the resulting combined stream of gas to the vicinity of ambient temperature preliminary to renewed compression thereof. There is also disclosed apparatus for carrying out the process. (auth)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 492 and 1909.

1731 (NP-18029) SPLITTING OF DEUTERONS WITH 14.1-MeV NEUTRONS. Diss. Nr. 4119, Bruellmann, Max (Eidgenoessische Technische Hochschule, Zurich (Switzerland)). 1968. 47p. (In German). Dep. CFSTI (U. S. Sales Only).

Thesis.

Using a fast time-of-flight spectrometer, the neutron spectra $d^2\sigma/d\Omega dE$ of the reaction D(n,2n)H were measured at an incident energy of 14.1 MeV. The investigation was carried out for eight angles lying between 7.5 and 75°, in the energy range of 2 MeV and the upper limit of the continuous distribution. At small angles, the peaks appearing in the central part and at the upper limit of the spectrum can be explained by means of the final state interaction between the break-up nucleons. The structure of the spectrum decreases at larger angles, the peaks disappearing almost completely for $\theta_{lab} > 30°$. The differential breakup cross section $d\sigma/d\Omega$ is obtained by integration of the break-up spectra over the given energy range. For the emission of neutrons in the forward hemisphere, the total cross section was found to be $\sigma_V = 255 \pm 30$ mb. The results were compared with various theoretical and experimental values. (auth)

1732 (ORNL-4317-2) DATA SUMMARIES (NUCLEAR-STRUCTURE PHYSICS). TABULAR AND GRAPHICAL SUMMARIES OF EXPERIMENTAL RESULTS REPORTED IN RECENT ISSUES OF SEVERAL JOURNALS. (Oak Ridge National Lab., Tenn.). Aug. 1969. 219p. Dep. CFSTI.

Data Summaries is a collection of tabular and graphical summaries of current experimental results in nuclear-structure physics. Entries from the 17 journals scanned include journal listings, titles, names of authors and affiliated institutions, keywords, abstracts, and tables, graphs, or level schemes which summarize the papers. (auth)

1733 INVESTIGATION OF THE REACTION ^{3}He(d,p)^{4}He WITH A POLARIZED ^{3}He TARGET AND 52 MeV DEUTERONS. Brueckmann, H.; Schmidt, F. K. (Univ., Karlsruhe, Ger. Kernforschungszentrums, Karlsruhe, Ger.). Nucl. Phys., A136: 81-6(1969).

An optically pumped ^{3}He target was used to measure the asymmetry of the protons of the reaction ^{3}He(d,p)^{4}He with deuterons of an energy of 52 MeV. The degree of target polarization was typically 0.1. The proton asymmetry distribution was investigated in the angular range from 30.5 to 74.2° c.m. The asymmetry reaches its maximum value of -0.38 ± 0.11 at 56.5° and vanishes near 35 and 75°. Comparison is made with proton polarization data which correspond to nearly the same energy. (auth)

1734 THE D(d,n)^{3}He REACTION FROM E_d = 5 TO 10 MeV. Thornton, S. T. (Univ. of Wisconsin, Madison). Nucl. Phys., A136: 25-34(1969).

The absolute differential cross section of the D(d,n)^{3}He reaction was determined at E_d = 5.0, 5.8, 9.0 and 10.0 MeV by the detection of the ^{3}He particles, and at E_d = 5.0 and 5.8 MeV by the neutron time-of-flight method. Good agreement was obtained between the two methods and the overall uncertainty in the cross sections is 2-4%. (auth)

1735 ELASTIC ELECTRON SCATTERING BY ^{4}He. Grypeos, M. E. (Univ. of Surrey, Eng.). Phys. Rev. Lett., 23: 793-6(Oct. 6, 1969).

An approach is presented for calculating the charge form factor of ^{4}He, based on a variational method with a "healing condition" for the determination of the correlated relative two-nucleon wave function. The fit to the experimental charge form factor is very good. (auth)

1736 MUONIC, PIONIC, AND KAONIC X-RAYS, ATOMIC DE-EXCITATION AND NUCLEAR ABSORPTION IN HELIUM. Berezin S. (Argonne National Lab., Ill.); Burleson, G.; Eartly, D.; Roberts, A.; White, T. O. Phys. Lett., 30B: 27-9(Sept. 1, 1969).

New X-ray data from muon, pion, and kaon capture in helium are consistent with available scattering measurements, with theoretically expected s-, p-, and d-state absorption rates, and with new atomic cascade calculations requiring Stark-induced sliding transitions to match observed yields. (auth)

1737 DIFFERENTIAL CROSS SECTIONS AND PHASE SHIFTS FOR ^{3}He + ^{4}He ELASTIC SCATTERING BETWEEN 27 AND 43 MeV. Schwandt, P.; Ridley, B. W.; Hayakawa, S.; Put, L.; Kraushaar, J. J. (Univ. of Colorado, Boulder). Phys. Lett., 30B: 30-2(Sept. 1, 1969).

Differential cross sections for ^{3}He elastic scattering from ^{4}He were measured at laboratory energies of 27.2, 30.4, 32.5, 36.8, 40.0, and 42.8 MeV. A phase-shift analysis was performed and the results were compared to the real phase shifts calculated with the resonating-group method. (auth)

1738 CROSS SECTION OF THE REACTION T(d,γ)^{5}He WITH EMISSION OF 16.7 MeV γ QUANTA AT 25-100 keV DEUTERON ENERGY. Bezotosnyi, V. M.; Zhmailo, V. A.; Surov, L. M.; Shvetsov, M. S. Yadern. Fiz., 10: 225-6(Aug. 1969). (In Russian).

Measurements of cross sections of the reaction T(d,γ)^{5}He with the emission of 16.7-MeV γ quanta at 25 to 100 keV deuteron energy are given. Ratios of cross sections of the reactions T(d,γ)^{5}He and T(d,n)^{4}He $\sigma_{(d,\gamma)}/\sigma_{(d,n)} = (2.1 \pm 0.6) \cdot 10^{-4}$ and the radiative width of the reaction T(d,γ)^{5}He $\Gamma_\gamma = 14 \pm 4$ eV are determined. Results obtained are compared with the data of other papers for the mirror reaction. (auth)

1739 BRANCHING RATIO FOR THE REACTION $\pi^- + {}^4\text{He} \rightarrow n + {}^3\text{H}$. Leung, Chun-ming (Western Michigan Univ., Kalamazoo) Nuovo Cim., Lett., 2: 389-93(Sept. 21, 1969).

Measurements were made for the at-rest and in-flight branching ratios of the reaction $\pi^- + {}^4\text{He} \rightarrow {}^3\text{H} + n$. The ratios were found to be the same, therefore giving no direct information on the question of orbital angular momentum in π^- capture by helium. (J.W.R.)

1740 A STUDY OF THE INTERACTION OF FAST TRITIUM IONS WITH TITANIUM. Strizhak, V. I.; Primenko, G. A.; Tustanovskii, V. T. At. Energ. (USSR), 27: 158-60(Aug. 1969). (In Russian).

The targets, which consisted of metal disks 24 mm in diameter and 1 mm thick in the case of titanium and a layer of titanium 1.55 mg/cm^2 thick sputtered onto a molybdenum backing in the case of the other metal target, were bombarded with 100 to 200 keV tritium ions in a high-vacuum accelerator which does not contain oil pumps. Saturation of the target with tritium was followed by measuring the neutron yield from the tritium-tritium interaction to give ^{4}He. The results showed that the target with the titanium implanted in a molybdenum backing is saturated with tritium much faster than is the pure titanium target. The neutron yield at saturation increased linearly with the tritium current density. The neutron yield of a titanium target implanted on a molybdenum backing and saturated with tritium (5 curies of activity) per unit of deuteron current on the target was higher than for a saturated target, and was equal to 1×10^8 neutrons. The fall in neutron yield per unit time at a constant triton current was less for the sputtered target than for the saturated target. Tritium atoms embedded in the titanium lattice are held more strongly than tritium atoms taken up by adsorption. These studies show that the most suitable target for a neutron generator is a sputtered titanium target with a metal for a backing material with a low tritium diffusion coefficient and a high heat conductivity such as silver, copper or molybdenum. (TTT)

1741 PHOTOPRODUCTION OF POSITIVE PIONS FROM ^{3}He. Jain, S. C. (Allahabad Univ., India). Phys. Rev., 184: 1226-7(Aug. 20, 1969).

Differential cross sections for the reaction $^3He(\gamma,\pi^+)^3H$ were calculated under the impulse-approximation theory, using two different types of wave functions. The parameters of these wave functions were obtained from a variational calculation of the binding energy for the trinucleons, using a central velocity-dependent potential. Though the cross sections calculated using a modified Feshbach wave function were in reasonable agreement with those obtained from the experiments by O'Fallon et al., the discrepancies reflect the inadequacy of the simplified impulse-approximation theory in calculation. (auth)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 50, 492, 1511, 1618, 1732, and 1871.

1742 (COO-1120-87) MO TRANSITIONS IN SPHERICAL NUCLEI. Bell, Donald A.; Davidson, J. P. (Kansas State Univ., Lawrence. Nuclear Physics Lab.). [1968]. Contract AT(11-1)-1120. 74p. Dep. CFSTI.

For light even–even nuclei, A < 40, the 0^- to 0^+ transition probability was calculated for the ($\gamma\gamma$), (γe), and (ee) processes. The assumption is made that the 0^- state decays through the giant dipole states. The resonance states were calculated according to Brown and Bolsterli particle–hole theory. This was done in both the Tamm–Dancoff (TD) approximation and the random phase approximation. In the TD approximation, various potentials were used to calculate the energy levels and eigenvectors to determine the potential dependence in the transition probability. Results for the 0^- state at 10.937 MeV in ^{16}O gives a value of 1×10^{-5} for the branching ratio B(MO,$\gamma\gamma$)/B(M1). The possibility of measuring the (γe) and (ee) processes in ^{16}O is more or less excluded by the exceedingly small value of the branching ratio B(MO, γe or ee)/B(M1). The results of calculations on ^{12}C, ^{28}Si, and ^{32}S are also presented. (auth)

1743 (COO-1120-88) PROGRESS REPORT, 1968–1969. (Kansas Univ., Lawrence. Nuclear Physics Lab.). Contract AT(11-1)-1120. 60p. Dep. CFSTI.

MAGNESIUM-24—energy levels from sodium-23(p,γ) reaction, width for (E)
NITROGEN-15—energy levels of, lifetimes for (E)
—energy-level transition in, multipolarities for (E)
NUCLEAR MODELS—shell, calculation of G-matrix from free nucleon–nucleon interaction (T)
OXYGEN-15—energy levels from nitrogen-15(p,γ) reactions, spin-parity assignments and widths for (E)
OXYGEN-16—energy levels of, lifetimes for (E)
—energy-level transitions in, multipolarities for (E)
OXYGEN-18—energy levels of, lifetimes for (E)
RADIATION TARGET CHAMBERS—design for Van de Graaff accelerator
SODIUM-23—proton reactions (p,γ) at 1.5 to 3 MeV, γ spectra for
VAN DE GRAAFF ACCELERATORS—scattering chamber for University of Kansas, design of (J.W.R.)

1744 (COO-1265-82) OCTUPOLE AND QUADRUPOLE TRANSITION RATES IN ^{19}F FROM SCATTERING OF 15 MeV DEUTERONS. Dehnhard, D.; Hintz, Norton M. (Minnesota Univ., Minneapolis. John H. Williams Lab. of Nuclear Physics). [1969]. 29p. Dep. CFSTI.

Angular distributions of 15.0-MeV deuterons scattered by ^{19}F were measured between Θ_{LAB} = 18 and 85°. Inelastic groups leaving ^{19}F in its five lowest lying excited states were observed using two position-sensitive detectors placed in the focal plane of a split-pole spectrometer. The elastic scattering cross section was analyzed using an optical model. B(E2)↓ values for the transitions from the $\frac{5}{2}^+$ (0.197 MeV) and the $\frac{3}{2}^+$ (1.56 MeV) states to the g.s. were found to be 9 ± 3 and 10 ± 3 W.U. (single particle units). They were calculated from the β_2 deformation parameter extracted from a DWBA analysis using a complex form factor derived from the optical model analysis with a surface absorption term. These results are in good agreement with results obtained from inelastic proton scattering and from Coulomb excitation experiments. However, the B(E3)↓ value for the $\frac{5}{2}^- \rightarrow \frac{1}{2}^+$ transition from the 1.35-MeV state was found to be 1.4 ± 0.6 W.U. as compared to 3.8 ± 0.6 W.U. from a (p,p′) experiment and to 12.0 ± 4.0 W.U. and 7.6 ± 1.3 W.U. from two different Coulomb excitation experiments. The results are compared to various model predictions. (auth)

1745 (JINR-P2-4613) CROSS SECTIONS OF INELASTIC INTERACTIONS OF α-PARTICLES WITH NUCLEI. Artykov, I. Z.; Barashenkov, V. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1969. 5p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Using an optical model the cross sections of the inelastic interactions of α-particles with the ^{12}C, ^{27}Al, $^{46,49}Ti$, $^{55,56}Fe$ and $^{63,65}Cu$ nuclei in the energy range more than 50 MeV were calculated. (auth)

1746 (RLO-1388-98) NUCLEAR POLARIZATION AND SUBSTATE POPULATIONS OF THE FIRST EXCITED STATE IN ^{12}C EXCITED IN INELASTIC ALPHA PARTICLE SCATTERING. Hayward, Thomas Doyle (Washington Univ., Seattle). 1969. 208p. Dep. CFSTI.
Thesis.

The correlation function W was measured for the reaction $^{12}C(\alpha, \alpha', \gamma)^{12}C$ (2^+,4.44 MeV) at a bombarding energy of 22.75 MeV. W was determined at 35 scattering angles with the aid of a calibrated NaI(Tl) gamma detector. An excitation function measured between 21.0 and 23.0 MeV clearly indicates resonant structures in the ^{16}O compound system at bombarding energies of 21.28, 21.9, and 22.32 MeV. The correlation measurements show that at this energy the $^{12}C^*$ recoil nuclei are strongly polarized at many scattering angles, and that the sign of this polarization can only change at two angles (~74°, and ~147° c.m.) within the range of investigation. Subsequent measurements of the sense of circular polarization of the de-excitation gamma rays were made using a magnetized cylindrical iron polarimeter. The measurements indicate that for scattering angles between 20 and 70° the m = −2 substate predominates; whereas at the more backward angles, 80 to 170°, the m = +2 substate predominates. The forward angle data are consistent with the classical picture of scattering from a repulsive potential while the equivalent interpretation at back angles is that of scattering from an attractive potential. The combined data make it possible to obtain, for the first time, values for the partial differential cross sections; i.e., the differential cross sections to each of the substates involved in the reaction. These partial cross sections show a great deal more structure than does their sum, which is the differential cross section to the 2^+ state. Attempts to obtain a fit to the elastic differential cross section using the Optical Model were essentially unsuccessful. In view of the resonance structure which was observed this is not surprising. Correspondingly, DWBA calculations of the inelastic differential cross sections were also unsuccessful; however, DWBA calculations of the partial cross sections were performed in order to determine whether or not any of the general features might be reproduced. In general even the very gross features of these partial cross sections are not adequately described. It is observed that the period of the oscillations in the m = −2 substate differential cross section is slightly smaller than the corresponding period in the m = +2 substate. A simple model is presented which indicates that the Coulomb force may be responsible for this effect. (A condensed version of this work is found in RLO-1388-100). (auth)

1747 (RLO-1388-100) SUBSTATE POPULATIONS AND NUCLEAR POLARIZATION PRODUCED BY INELASTIC ALPHA PARTICLE SCATTERING ON ^{12}C. Hayward, T. D.; Schmidt, F. H. (Washington Univ., Seattle. Dept. of Physics). [1969]. 45p. Dep. CFSTI.

The normalized $\alpha-\gamma$ angular correlation in the reaction plane for excitation of the 4.44-MeV, 2^+ state of ^{12}C was measured at 22.750 MeV. These data yield the relative populations, $(a_m)^2$, of the three magnetic substates referred to the normal to the reaction plane. The ambiguity between $(a_{+2})^2$ and $(a_{-2})^2$ was resolved by coincidence measurements of the circular polarization of de-excitation γ rays emitted near the normal to the reaction plane. The inelastic scattering process can then be dissected into partial differential cross sections, σ_m, to the substates. The results show that each σ_m has a different angular dependence. σ_0 has the most regular and pronounced diffraction-like structure; σ_{-2} dominates out to 75°, and σ_{+2} dominates thereafter. Thus, the excited nuclei spin in the sense of classical hard sphere scattering with friction out to ≈75°, and in the reverse sense from ≈75° to ≈170°. The nuclear polarization exhibits an oscillatory character as a function of angle. Comparison of the results with diffraction-model calculations, and with distorted-wave Born-approximation calculations is poor. In principle, the experimental method, though difficult, could be applied to nuclei which are more accurately described by nuclear models than is ^{12}C. (A more complete version of this work is found in RLO-1388-98.) (auth)

1748 CROSS-SECTIONS FOR DESTRUCTION OF ^6Li AND ^7Li BY LOW-ENERGY PROTONS. Audouze, J.; Reeves, H. (Institut d'Astrophysique, Paris. Service d'Electronique Physique, Saclay, France). Astrophys. J., 158: 419-21 (Oct. 1969).

S Gamow factors based on experimental determination of cross

sections for destruction of ^{6}Li and ^{7}Li by low-energy protons are given. (W.D.M.)

1749 ELASTIC AND INELASTIC SCATTERING OF 14.1-MeV NEUTRONS BY ^{16}O AND ^{18}O. Meier, D.; Bruellmann, M.; Jung, H.; Marmier, P. (Laboratorium fuer Kernphysik ETH, Zurich). Helv. Phys. Acta, 42: 813-41(1969). (In German).

Angular distributions for elastic and inelastic scattering of 14.1 MeV neutrons by ^{16}O and ^{18}O were measured in the angular range $7.5° \leq \theta \leq 155°$ using a fast time-of-flight spectrometer and targets of $H_2{}^{16}O$, $D_2{}^{16}O$ and $D_2{}^{18}O$. Absolute differential cross sections were determined for the states or groups of states at 0, 6.1, 7 MeV in ^{16}O and at 0, 1.98, 3.7, 5.3 MeV in ^{18}O as well as the integrated cross sections for these levels and the levels at 6.3, 7.12, 7.62 MeV in ^{18}O. The results are compared with optical model predictions and direct interaction theories. In the case of ^{16}O, the experimental data are in good agreement with previous work. The angular distribution for neutrons inelastically scattered to the 6.1 MeV state differs from the corresponding proton data and is not well reproduced by theoretical curves. For ^{18}O appreciably larger scattering cross sections were observed for Q = 0 and −1.98 MeV than in comparable proton measurements. It may be concluded, that the averaging over the level structure in these light nuclei is not sufficient. In a supplementary measurement the total cross section for ^{18}O was determined by a transmission experiment to 1610 ± 70 mb, which is considerably higher than the previously reported value. (auth)

1750 POLARIZATION AND DIFFERENTIAL CROSS SECTION OF THE NEUTRONS FROM THE REACTION ^{9}Be(α,n)^{12}C. Klages, H. O.; Schoelermann, H. (Univ., Hamburg). Z. Phys., 227: 344-51(1969). (In German).

The differential cross section and the angular distribution of the polarization of neutrons from the reaction ^{9}Be(α,n) leading to the ground state of ^{12}C were determined at 1.75 and 1.96 MeV energy of the α-particles. The polarization was measured by left-right asymmetry induced by elastic scattering from ^{4}He. From Blatt, Biedenharn and Simon, Welton theory analysis a set of spectroscopic data was obtained for five states of the compound nucleus ^{13}C. (auth)

1751 NOTE ON INFLUENCE OF DIPOLE–QUADRUPOLE COUPLING UPON THE ^{12}C(γ,n)^{11}C CROSS SECTION. Baciu, G.; Catana, D.; Deberth, C.; Iliescu, C.; Cirstoiu, B. (Inst. for Atomic Physics, Bucharest). Z. Phys., 227: 336-9(1969).

The cross section for the ^{12}C(γ,n)^{11}C reaction was measured from threshold to 25 MeV with a small energy bin (100 keV). The giant resonance was resolved into a very well defined triplet structure. It seems that the shape of the ^{12}C(γ,n)^{11}C cross section is influenced by the dipole-quadrupole coupling. (auth)

1752 INVESTIGATION OF THE FIRST FOUR EXCITED LEVELS OF ^{6}Li BY ELECTRON SCATTERING. Eigenbrod, Friedrich (Technische Hochschule, Darmstadt, Ger.). Z. Phys., 228: 337-52(1969). (In German).

Inelastic electron scattering cross sections were measured for energies below 60 MeV and momentum transfers q between 0.2 and 0.6 fm^{-1}. Ground state radiative widths Γ_γ^0 and transition radii R_{tr} were deduced. 2.18 MeV: $\Gamma_\gamma^0(E2) = (4.40 \pm 0.34) \cdot 10^{-4}$ eV, R_{tr} = (4.28 ± 0.39) fm; 3.56 MeV: $\Gamma_\gamma^0(M1) = (8.31 \pm 0.36)$ eV, $R_{tr} = (2.90 \pm 0.10)$ fm; 4.27 MeV: $\Gamma_\gamma^0(E2) = (5.4 \pm 2.8) \cdot 10^{-3}$ eV, $R_{tr} = (3.4 \pm 1.2)$ fm. The excitation of the 5.37-MeV level shows a transverse angular dependence. (auth)

1753 SEARCH FOR THE LOWEST T = 2 STATE OF ^{8}Be: EXPERIMENTAL. Black, J. L.; Caelli, W. J.; Livesey, D. L.; Watson, R. B. (Australian National Univ., Canberra). Phys. Lett., 30B: 100-2(Sept. 15, 1969).

An anomaly with width Γ = 10 ± 3 keV has been observed in the excitation functions for ^{6}Li + d reactions at an excitation energy in ^{8}Be of 27.483 ± 0.010 MeV. It is interpreted as being due to the isospin forbidden excitation of the lowest T = 1 state of ^{8}Be. (auth)

1754 SEARCH FOR THE LOWEST T = 2 STATE OF ^{8}Be: THEORY. Barker, F. C.; Kumar, N. (Australian National Univ., Canberra). Phys. Lett., 30B: 103-4(Sept. 15, 1969).

Shell model calculations suggest that ^{6}Li + d reactions should be used to search for the lowest T = 2 state of ^{8}Be. (auth)

1755 POLARIZATION STUDIES OF THE ^{16}O(γ,n)^{15}O REACTION. Cole, G. W.Jr.; Firk, F. W. K.; Phillips, T. W. (Yale Univ., New Haven). Phys. Lett., 30B: 91-3(Sept. 15, 1969).

The polarization of photoneutrons from the reaction ^{16}O(γ,n)^{15}O has been studied at angles of 45° and 90° with the ^{12}C(n,n)^{12}C reaction as an analyzer. The neutron energies were determined with a nanosecond time-of-flight spectrometer. Appreciable polarization is observed at 45° throughout the giant dipole resonance region. (auth)

1756 THE HEAVY-PARTICLE STRIPPING REACTION IN THE ELASTIC AND INELASTIC SCATTERINGS OF ^{3}He AND ^{3}T BY LIGHT NUCLEI. THE ^{9}Be(^{3}He,^{3}He)^{9}Be AND ^{16}O(^{3}He,^{3}He)^{16}O REACTIONS. Honda, Tsuyoshi (Univ., Grenoble, France). Nucl. Phys., A136: 183-9(1969).

It was shown that the backward peaks appearing at large angles in the elastic scattering of ^{3}He (or t) by light nuclei which are not accounted for by the usual optical model, can be interpreted by the same exchange effect as the heavy-particle stripping reaction in nuclear rearrangement collisions, as in the case of the elastic and inelastic scatterings of α-particles by the nuclei. The differential cross section is written in the plane wave cut-off Born approximation, where the spectroscopic factor of the ^{3}He (or t) cluster reduced width was calculated from the nuclear shell model. As a typical example, the angular distributions of the ^{9}Be(^{3}He,^{3}He)^{9}Be and ^{16}O(^{3}He,^{3}He)^{16}O reactions are calculated and the remarkably good agreement with the experimental data is obtained and the "single-particle" cluster reduced widths of ^{3}He are deduced by these analyses. Validity of the present approximation and other attempts to explain the peaks are also discussed. (auth)

1757 ^{11}B(^{3}He,d)^{12}C SPECTROSCOPIC FACTORS. Miller, P. D. (Oak Ridge National Lab., Tenn.); Duggan, J. L.; Duncan, M. M.; Dangle, R. L.; Coker, W. R.; Lin, Jung. Nucl. Phys., A136: 229-40(1969).

Particle-identification techniques were used to study the ^{11}B(^{3}He,d)^{12}C reaction. Angular distributions were measured for incident ^{3}He energies of 10, 12 and 18 MeV for residual states in ^{12}C up to 16.11 MeV excitation. Elastic scattering of ^{3}He by ^{11}B was measured at the same energies in order to extract optical-model parameters. The angular distributions were analyzed using DWBA calculations in order to obtain absolute spectroscopic factors. Zero-range DWBA was used with and without radial cut-off, and approximate finite-range DWBA calculations were also performed. Comparisons of the spectroscopic factors extracted using ^{11}B(^{3}He,d)^{12}C and ^{11}B(d,n)^{12}C are given. (auth)

1758 E3 COULOMB EXCITATION OF ^{19}F. Alexander, T. K.; Haeusser, O.; Allen, K. W.; Litherland, A. E. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 47: 2335-42 (Nov. 1, 1969). (AECL-3434).

The E3 matrix element connecting the ground state with the $^{5}/_{2}^{-}$, 1346-keV level in ^{19}F has been measured by projectile excitation of a ^{19}F beam and observation of the 1236-keV de-excitation gamma ray in Ge(Li) detectors. The thick-target yield of the 1236-keV gamma ray was 1.6, 6.0, 9.8, and 23 gammas per 10^{10} projectiles at bombarding energies of 22, 25, 26, and 28 MeV, respectively. The average value of the strength of the E3 transition deduced from these measurements is $|M|^2(E3) = 7.6 \pm 1.3$ W.u. In addition, the E2 Coulomb-excitation cross section of the 1554-keV level was measured and the reduced transition strength of the E2 transition from the 1554-keV level to the ground state was found to be 6.8 ± 0.7 W.u. Comparisons are made with model predictions. (auth) (UK)

1759 SU_3 STUDY OF ^{18}O, ^{18}O, AND ^{20}F. Hodgson, R. J. W. (Univ. of Alberta, Edmonton). Can. J. Phys., 47: 2269-82 (Oct. 15, 1969).

A method for performing SU_3 calculations is outlined which combines the operator expansion procedure of Banerjee and Levinson together with the determinantal wave functions introduced by Moshinsky. The technique is quite suitable for computer calculations and is applied to ^{18}O, ^{18}O, and ^{20}F, using three different central residual interactions together with a spin-orbit force. (auth)

1760 EFFECT OF NUCLEAR FORM FACTOR ON π^+ MESON SCATTERING ON NUCLEI. Grashin, A. F.; Shalamov, Ya. Ya. (Moscow Pedagogical Inst.). Yadern. Fiz., 10: 341-5(Aug. 1969). (In Russian).

The reaction A(π^+,π^+p)B* on nuclei of freon mixture at the π^+ meson energy E = 70 ± 20 MeV was studied. Experimental data obtained may be explained on the basis of peripheral collision model with recoil nucleus excitation B*. For the form-factor A → p + B* contained in the corresponding pole graph, the previously given functional dependence on the momentum transfer is observed. (auth)

1761 ELASTIC SCATTERING OF 2.4-4.0-MeV DEUTERONS ON ^{19}F, ^{23}Na, AND Cl. Zabegai, V. M.; Melenevskii, A. E.; Nemets, O. F.; Nemykin, V. N.; Stryuk, Yu. S.; Terenetskii, K. O. (Physical-Technical Inst., Kharkov). Yadern. Fiz., 10: 227-32 (Aug. 1969). (In Russian).

Excitation function for deuterons elastically scattered on ^{19}F, ^{23}Na, and Cl were measured in the energy range 2.4 to 4.0 MeV at angles of 70 and 170° with energy steps of 50 keV. Angular distributions for a number of energy values were also measured. The

obtained results were analyzed in framework of the optical model with a six-parameter potential. Energy dependence of diffusion parameters of the real and imaginary parts of the potential was introduced in order to obtain reasonable sets of the optical potential parameters. (auth)

1762 INTERACTION OF PHOTONS WITH CARBON NUCLEUS IN THE ENERGY RANGE 30-40 MeV. Taran, G. G. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 10: 211-16(Aug. 1969). (In Russian).

The sum cross section for the reactions $^{12}C(\gamma,p)^{11}B$, $^{12}C(\gamma,pn)^{10}B$, $^{12}C(\gamma,pn\alpha)^{6}Li$, $^{12}C(\gamma,2p)^{9}Be$, $^{12}C(\gamma,2p)^{10}Be$, $^{12}C(\gamma,p\alpha)^{7}Li$, $^{12}C(\gamma,n\alpha)^{7}Be$, $^{12}C(\gamma,pt)2^{4}He$, $^{12}C(\gamma,n^{3}He)2^{4}He$, and $^{12}C(\gamma,^{3}He)^{9}Be$ were measured. Possible mechanisms of the interaction of photons with the carbon nucleus in the energy range 32 to 37 MeV are discussed. (auth)

1763 EXPERIMENTAL STUDY OF TWO- AND THREE-PARTICLE REACTIONS INVOLVING ^{8}Li AND ^{8}B PRODUCTION IN CAPTURE OF SLOW π^- MESONS BY NUCLEI OF ^{12}C, ^{14}N, ^{16}O. Batusov, Yu. A.; Bunyatov, C. A.; Sidorov, V. M.; Chaika, Yu. S.; Chernev, Khr. M.; Yarba, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 10: 354-7(Aug. 1969). (In Russian).

Two- and three-particle reactions involving ^{8}Li and ^{8}B production from the capture of π^- mesons by the nuclei of C, N, and O, were studied using photoemulsions. Relative probabilities of two-particle reactions on light nuclei are found to be less than (1 to 5) 10^{-4}. Energy spectra and angular correlations of secondary particles are measured for the reaction $\pi^- + {}^{12}C \rightarrow {}^{8}Li + {}^{3}He + n$. Experimental results are compared with predictions of the theory of direct nuclear reactions. (auth)

1764 ENERGY DEPENDENCE OF PROXIMITY SCATTERING. Thievent, G.; Lang, J.; Mueller, R.; Marmier, P. (Eidgenoessische Technische Hochschule, Zurich). Phys. Lett., 30B: 23-4(Sept. 1, 1969).

The dependence of proximity scattering on the energy of the incident particles was investigated in the reaction $^{7}Li(d,n\alpha)^{4}He$. (auth)

1765 ON THE MECHANISM OF THE REACTIONS $(\pi,\pi N)$ ON LIGHT NUCLEI. Kolybasov, V. M.; Smorodinskaya, N. Ya. (Inst. for Experimental and Theoretical Physics, Moscow). Phys. Lett., 30B: 11-13(Sept. 1, 1969).

It is shown that the available data on the $(\pi,\pi N)$ and $(\pi,\pi d)$ reactions on light nuclei in the N_{33} isobar energy region give evidence for the quasi-elastic knock out contribution to be either dominant or comparable with the contribution of other mechanisms. (auth)

1766 HALF-LIFE OF ^{11}Li, OF ^{27}Na, AND OF THE NEW ISOTOPES ^{28}Na, ^{29}Na, ^{30}Na, AND ^{31}Na PRODUCED IN HIGH-ENERGY NUCLEAR REACTIONS. Klapisch, R. (Centre de Spectrometrie Nucleaire et de Spectrometrie de Masse, Orsay, France. Inst. de Physique Nucleaire, Orsay, France); Thibault-Philippe, C.; Detraz, C.; Chaumont, J.; Bernas, R.; Beck, E. Phys. Rev. Lett., 23: 652-5(Sept. 22, 1969).

Our on-line mass-spectrometer technique has enabled us to measure the half-lives of very neutron-rich Li and Na isotopes produced in the reaction of 24-GeV protons on heavy nuclei. A β energy spectrum of ^{27}Na has also been obtained. (auth)

1767 OPTICAL-MODEL ANALYSIS OF THE ELASTIC SCATTERING OF COMPLEX NUCLEI AT LOW ENERGIES. Voos, Ursula C.; von Oertzen, W.; Bock, R. (Max-Planck-Institut fuer Kernphysik, Heidelberg. Univ., Marburg/Lahn, Ger.). Nucl. Phys., A135: 207-24(1969).

Angular distributions of the elastic scattering of ^{10}B, ^{11}B, ^{16}O and ^{19}F on ^{12}C and ^{16}O on ^{11}B were measured at incident energies between 18 and 60 MeV. The data were analyzed with the optical model. When applying the concept of strong absorption at small internuclear distances, a consistent description for the various cases was found. In the analysis, special attention was paid to the interference effects of the elastic scattering with the exchange transfer. (auth)

1768 POLARIZATION OF PROTONS FROM THE REACTION $^{10}B(d,p_0)^{11}B$ AT DEUTERON ENERGIES OF 1.15, 1.40, AND 1.85 MeV. Dietze, G.; Stahl, K. D. (Univ., Hamburg). Z. Phys., 228: 172-81(1969). (In German).

Angular distributions of the polarization of protons from the reaction $^{10}B(d,p_0)^{11}B$ were measured between 20 and 148° at deuteron energies of 1.15, 1.40 and 1.85 MeV. Measurements were made by double-scattering techniques using elastic scattering from carbon as the analyzer. The results show a strong energy dependence and are in significant accordance with $^{10}B(d,n_0)^{11}C$ data. Calculations were performed for the mirror reactions $^{10}B(d,p_0)^{11}B$ and $^{10}B(d,n_0)^{11}C$ in the framework of the Simon and Welton theory assuming two broad compound-states in ^{12}C, a 2^+ state at 26.02 MeV and a 3^- state at 26.89 MeV excitation energy. (auth)

1769 DEUTERON PRODUCTION IN NUCLEI BY PROTONS OF FROM 1 TO 3 BeV. Edge, R. D.; Knox, H. H. (Univ. of South Carolina, Columbia). Phys. Rev., 184: 1034-40(Aug. 20, 1969).

The deuteron yield and momentum spectrum for targets of Be, C, Cu, and Pb bombarded by 1-, 2-, and 3-BeV protons from the Cosmotron was found at angles of 0, 17, and 32°, using a magnetic spectrometer and time-of-flight telescope. The results cannot be explained in terms of a simple pickup, evaporation, or nucleon-nucleon statistical production process. Two models involving two-stage processes have been proposed, namely, the indirect pickup process and a model in which nuclear matter "catalyzes" the coalescing of two cascade nucleons into a deuteron. The results show that, at higher momenta in the deuteron spectrum, agreement can be obtained with the cascade theory. At the lower end of the momentum spectrum, deuterons may arise by the indirect pickup process. (auth)

1770 ENERGY AND ANGULAR DEPENDENCE OF DIFFERENTIAL CROSS SECTIONS FOR THE $^{16}O(^{16}O,\alpha)^{28}Si$ REACTION. Shaw, R. W.; Norman, J. C.; Vandenbosch, R.; Bishop, C. J. (Univ. of Washington, Seattle). Phys. Rev., 184: 1040-60 (Aug. 20, 1969).

Excitation functions for elastic scattering and α-particle emission were measured for 35- to 39-MeV oxygen projectiles incident on an oxygen target. Differential cross sections for α-particle emission to the ground and first excited states of ^{28}Si are approximately 10–100 $\mu b/sr$. The angular distribution at 36-MeV laboratory bombarding energy indicates that $J = 12$ angular momentum states of the compound nucleus are the dominant contributors for α decay to the ^{28}Si ground state. The fluctuation width obtained from both the elastic and the α-particle-emission channel is 76 ± 17 keV. Neither the fine nor gross structure in the elastic scattering excitation function is correlated with fluctuations in the cross section for α-particle emission from the compound nucleus. The level density of spin-12 states of the ^{32}S compound nucleus at an excitation energy of 34.2 MeV was determined to be 2000 levels per MeV. Statistical-model calculations of the level density, average cross sections, and fluctuation widths require a value of the nuclear level-density parameter a between A/7 and A/9. (auth)

1771 OPTICAL-MODEL ANALYSIS OF $p-^{16}O$ ELASTIC SCATTERING FROM 23 TO 53 MeV. van Oers, W. T. H. (Univ. of Manitoba, Winnipeg, Can.); Cameron, J. M. Phys. Rev., 184: 1061-7(Aug. 20, 1969).

Differential cross section and polarization angular distributions for $p-^{16}O$ elastic scattering together with total-reaction cross section data in the energy range 23 to 53 MeV were analyzed using the eleven-parameter optical-model search code SEEK. The optical potential contains a surface-absorption term of Gaussian form rather than the usual Woods–Saxon derivative form. Emphasis was placed upon finding the energy dependence of the strengths of the potentials. Consequently, an averaged set of geometrical parameters was first defined, and then a search was made for the strengths of the real central, the volume and surface parts of the imaginary central, and the real spin-orbit potentials. The energy dependence of the real central potential for ^{16}O in the energy range 23 to 53 MeV can be represented by $dV/dE \cong -0.29$. The fits to the large-angle data are in general unsatisfactory. Difficulties were encountered in fitting the three sets of data below 30 MeV. This is consistent with what is expected from the nonmonotonic energy behavior of the differential cross sections and polarizations in this energy region. (auth)

1772 STRUCTURE OF ^{15}N AND THE $^{14}N(d,p)^{15}N$ REACTION. Phillips, G. W.; Jacobs, W. W. (Univ. of Washington, Seattle). Phys. Rev., 184: 1052-60(Aug. 20, 1969).

Angular distributions were measured for the $^{14}N(d,p)^{15}N$ reaction to levels up to 10.80-MeV excitation in ^{15}N. Distorted-wave Born-approximation fits were obtained to most of these levels and absolute spectroscopic factors were extracted. Although the spectroscopic factors for the low-lying $\frac{5}{2}^+$, $\frac{1}{2}^+$ doublet at 5.27, 5.30 MeV are very small, those for the next four positive-parity levels are close to the single-particle value of 1. To explain these features a weak-coupling model is proposed, in which an $s_{\frac{1}{2}}$ or $d_{\frac{5}{2}}$ particle is coupled to a core corresponding to the 1^+, $T = 0$ ground state of ^{14}N or to the 0^+, $T = 1$ first excited state. Explicitly included in the model is the splitting due to the $T \cdot t$ force, which accounts for the low-lying position of the $\frac{5}{2}^+$, $\frac{1}{2}^+$ doublet. (auth)

1773 MATRIX ELEMENTS OF THE LAMBDA-NUCLEON POTENTIAL FROM PHASE SHIFTS. Jackson, A. D.; Lande, A.;

Sauer, P. U. (Univ. of California, Berkeley). Phys. Lett., 30B: 233-5(Oct. 13, 1969).

Experimental ΛN phase shafts used to deduce matrix elements of the ΛN potential in a harmonic oscillator basis. An inconsistency between these matrix elements and experimental Λ separation energies for light hypernuclei is noted. (auth)

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Refer also to abstracts 179, 254, 257, 492, 1511, 1721, 1732, 1742, 1743, 1745, 1760, 1761, 1769, 1770, 1822, and 1835.

1774 (AECL-3417) PHYSICS DIVISION PROGRESS REPORT, APRIL 1, 1969-JUNE 30, 1969. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). 100p. (PR-P-82). Dep. CFSTI (U. S. Sales Only). CAN $2.00.

Research projects of the branches of nuclear physics, general physics, neutron physics, theoretical physics, and mathematics and computation in progress from April 1 to June 30, 1969, are summarized. (J.W.R.)

1775 (ANL-7575, pp 170-6) NUCLEAR CONSTANTS. Dudey, N. D.; Crouthamel, C. E. (Argonne National Lab., Ill.).

Capture cross sections for ^{87}Rb, ^{50}Ti, and ^{50}V are presented for neutron energies of 100 to 1700 MeV. Isomeric capture cross sections for ^{85}Rb and ^{89}Y are also presented. The cross sections are compared with theoretical calculations using the computer codes ABACUS and NEARREX. Integral cross-section measurements made on type 304L stainless steel irradiated in EBR-II are presented. The total flux per megawatt was determined from the measurements. (J.W.R.)

1776 (ANU-P-467) EVIDENCE FOR AND INTERPRETATION OF THE SELECTIVE OCCURRENCE OF INTERMEDIATE STRUCTURE IN EXCITATION FUNCTIONS FROM THE REACTION ^{23}Na(p,p')^{23}Na. Hellstroem, J.; Dallimore, P. J.; Davidson, W. F. (Australian National Univ., Canberra. Research School of Physical Sciences). 1969. 9p. Dep. CFSTI (U. S. Sales Only).

The selective occurrence of intermediate structure in the compound nucleus ^{24}Mg observed in the excitation functions for decay through different exit channels is interpreted on the basis of the statistical model of intermediate structure of Moldauer and the compound nucleus theory of Hauser and Feshbach. (auth)

1777 (ANU-P-470) SPIN OF THE 426-keV LEVEL IN ^{62}Cu. Davidson, W. F.; Dallimore, P. J.; Hellstroem, J. (Australian National Univ., Canberra. Research School of Physical Sciences). [1969]. 10p. Dep. CFSTI (U. S. Sales Only).

The spin of the 426-keV level in ^{62}Cu excited through the ^{62}Ni (p,nγ)^{62}Cu reaction was measured to be 3$^+$. (auth)

1778 (BNL-13884) EXPERIMENTAL STUDIES OF RESONANCE NEUTRON CAPTURE GAMMA RAYS. Chrien, R. E. (Brookhaven National Lab., Upton, N. Y.). Aug. 5, 1969. 50p. (CONF-690802-2). Dep. CFSTI.

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden.

The usefulness of γ-ray spectroscopy of resonance neutron-capture reactions in nuclear structure studies is examined from several points of view. Illustrations are given of the applications of resonance γ-ray spectroscopy. Some of the interpretations of the available experimental data are discussed. (J.W.R.)

1779 (COO-1265-81) ANALYSIS OF PROTON ELASTIC SCATTERING USING POTENTIALS DERIVED FROM NUCLEON DENSITY DISTRIBUTIONS AND TWO BODY POTENTIALS. Greenlees, G. W.; Makofske, W.; Pyle, G. J. (Minnesota Univ., Minneapolis. Dept. of Physics). [1969]. 36p. Dep. CFSTI.

Proton elastic scattering data at 30.3 MeV are analyzed using the optical model recently developed by Greenlees, Pyle, and Tang (Phys. Rev., 171, 1115 (1968)). The present analysis differs from that given in the original paper in using a model-exact treatment of the spin orbit and isospin terms of the potential. The quality of the fits obtained is insensitive to the detailed manner in which the potential is constructed and, in particular, to the choice of nucleon-nucleon force parameters. These parameters are therefore taken from an analysis of low energy nucleon-nucleon scattering data thus enabling the present analysis to give nuclear neutron rms radii. The n-p rms radius difference is about zero for medium weight elements and 0.1 to 0.2 F for heavy elements. Evidence is presented supporting the conclusion that the volume integral and the rms radius of the real central potential are the well defined quantities which can be deduced from analyses of elastic proton scattering data. (auth)

1780 (RLO-1388-101) INELASTIC SCATTERING OF 42-MeV ALPHA PARTICLES BY ^{25}Mg. Blair, J. S.; Naqib, I. M. (Washington Univ., Seattle. Dept. of Physics). [1969]. 46p. Dep. CFSTI.

Cross sections were measured for elastic and inelastic scattering of 42-MeV α particles by ^{25}Mg in the range θ(lab) = 10 to 60°. Six inelastic α groups were identified at the following measured -Q values: 1.59, 1.94, 2.55, 2.75 (doublet), 3.400 (doublet), and 4.05 MeV. The cross sections are analyzed in terms of the distorted-wave Born-approximation version of the extended optical model and the smoothed Fraunhofer inelastic diffraction model. A general discussion is given of the transition strengths of odd mass nuclei within the context of the strong coupling rotational model or modifications thereof and application is made to the present results. The main conclusions are: Inelastic scattering within the ground state band supports the rotational model in its simplest form. Comparison of the elastic cross sections from ^{24}Mg, ^{25}Mg and ^{26}Mg indicates the presence of a quadrupole contribution to the elastic cross section from ^{25}Mg consistent with the strong coupling prediction. The λ = 2 single nucleon contribution to transitions into the lowest K = $\frac{1}{2}^+$ band appears to be very small. The excitation corresponding to the known level at 4.057 MeV suggests that this level arises from coupling a gamma vibration to the ground state band. The second K = $\frac{1}{2}^+$ band may have the same origin although other evidence indicates that there is at least a sizable admixture of a single nucleon orbital to this band. (auth)

1781 NUCLEAR γ RAYS PRODUCED BY π MESONS. Poelz, G.; Schmitt, H.; Tauscher, L.; Backenstoss, G.; Charalambus, S.; Daniel, H.; Koch, H. (CERN, Geneva. Max-Planck-Institut fuer Kernphysik, Heidelberg. Univ., Karlsruhe, Ger. Technische Hochschule, Munich). Z. Phys., 227: 311-19(1969).

Energies and yields of nuclear γ-rays accompanying π-mesic X-ray spectra were measured. The γ-lines arise either in nuclei of the atomic number of the target, or in nuclei of smaller atomic numbers. The first kind of γ-rays are due mainly to inelastically scattered neutrons produced by pion capture in another target nucleus (secondary process), while the second kind are due to ordinary nuclear capture (primary process). (auth)

1782 GAMMA RAYS FROM THE ^{24}Mg(p,γ)^{25}Al REACTION FOR PROTON ENERGIES E_p = 800 keV TO E_p = 1,830 keV. van Reenen, R. J.; Du Toit, Z. B.; Mouton, W. L. (Univ. of Stellenbosch, South Africa). Z. Phys., 227: 326-35(1969).

The yield curve and resonance strengths of resonances in the ^{24}Mg(p,γ)^{25}Al reaction for the proton energy range E_p = 800 keV to 1,830 keV, were determined and the existence of a resonance at E_p = 1.184 MeV confirmed. Single energy spectra as well as decay schemes and branching ratios are given for these resonances. An upper level of 2.0×10^{-15} sec for the lifetime of the 3.079-MeV level in the ^{25}Al results from a Doppler shift attenuation measurement carried out on the 2.624-MeV gamma line originating in the 3.070 MeV → 0.455 MeV transition in ^{25}Al. (auth)

1783 A NOTE ON ^{60}Co DECAY. Raman, Subramanian (Oak Ridge National Lab., Tenn.). Z. Phys., 228: 387-90 (1969).

The γ-rays from ^{60}Co were studied with a 30 cm^3 Ge(Li) detector. Gamma rays of energies 826.4 and 2,158.9 keV which are expected on the basis of the ^{60}Co decay scheme were sought but not observed. Their intensities are <0.02% and <0.002%, respectively, of the ^{60}Co disintegrations. Any direct feeding from the (5$^+$) ^{60}Co ground state to the (2$^+$) 2,159 keV level is <0.022%, yielding a log ft >12.3 for the 664 keV second-forbidden unique β-transition. (auth)

1784 LIFETIME OF THE FIRST EXCITED STATE IN ^{29}P AND ^{29}Si. Bizzeti, P. G. (INFN, Florence); Bizzeti-Sona, A. M.; Cambi, A.; Maurenzig, P. R.; Signorini, C. Phys. Lett., 30B: 94-6(Sept. 15, 1969).

The mean lives of the first excited states in ^{29}P and ^{29}Si have been measured with the Doppler shift attenuation method as τ_m = 0.18 ± 0.03 and 0.43 ± 0.05 ps, respectively. The relative importance of the isoscalar and of the two isovector terms in the M1 transition amplitudes has been obtained from β and M1 strengths in analogous transitions. (auth)

1785 LOW LYING LEVELS IN ^{81}Br. Salomon, M.; Hojvat, C. (Univ. of British Columbia, Vancouver). Can. J. Phys., 47: 2255-9(Oct. 15, 1969).

Coulomb excitation of Br targets and the reaction ^{80}Se(p,γ)^{81}Br were used to populate the low lying excited states of ^{81}Br and an energy level scheme is proposed. The reduced transition probability from the ground state to the first state of ^{81}Br (276 keV) was measured to be B(E2) = 410 ± 40 e^2 f^4. (auth) (CANADA)

1786 NEUTRON ACTIVATION RESONANCE INTEGRALS OF ^{64}Zn, ^{68}Zn, ^{85}Rb, ^{100}Mo, ^{102}Ru, ^{113}In, ^{123}Sb, AND ^{180}Hf. Ricabarra, M. D.; Turjanski, R.; Ricabarra, G. H. (Comision Nacional de Energia Atomica, Buenos Aires). Can. J. Phys., 47: 2031-36(Oct. 1, 1969).

The ratio of resonance integral to thermal activation cross sections of the isotopes ^{64}Zn, ^{68}Zn, ^{85}Rb, ^{100}Mo, ^{102}Ru, ^{113}In, ^{123}Sb, and ^{180}Hf relative to gold was determined by measuring cadmium ratios. The standard gold or a secondary standard was mixed uniformly in the samples and the activities resolved with a lithium-drift germanium γ-ray spectrometer. Expressed as Westcott S_0 values the results were: ^{64}Zn = 2.06 ± 0.03, ^{68}Zn = 3.72 ± 0.14, ^{85}Rb = 18.4 ± 0.6, ^{100}Mo = 21.7 ± 0.8, ^{102}Ru = 3.76 ± 0.03, ^{113}In = 24.7 ± 0.5, ^{123}Sb = 28.3 ± 2.1, ^{180}Hf = 2.17 ± 0.09. All measurements are relative to S_0 = 17.7 for gold. (auth) (CANADA)

1787 A STATISTICAL MODEL ANALYSIS OF FLUCTUATIONS IN THE ELASTIC AND INELASTIC PROTON SCATTERING ON ^{54}Cr AND ^{56}Fe. Ernst, J.; Harney, H. L.; Kotajima, K. (Max-Planck Institut fuer Kernphysik, Heidelberg). Nucl. Phys., A136: 87-121(1969).

Excitation functions of the proton elastic scattering on the doubly even nuclei ^{54}Cr and ^{56}Fe were measured together with the strong transitions to the 2^+ first excited states at proton energies between 9 and 10 MeV and, for ^{56}Fe only, between 11 and 12 MeV. Rapid cross-section fluctuations are found for scattering angles between 43 and 173°. Fourier analysis as well as autocorrelation functions are applied for data reduction. The interpretation is based on Ericson's statistical model following Moldauer's treatment. A coupled-channel calculation combined with the mean square variation of the cross sections allowed the separation of the direct and compound nucleus parts of the averaged cross sections. The angular distribution of the compound nucleus cross section is in agreement with Hauser–Feshbach calculations. The theoretically predicted enhancement of the compound elastic cross section by a factor of about 2 is confirmed. Mean level widths are deduced and found to be about 15 keV for ^{55}*Mn and 4 keV for ^{57}*Co at 17.6 MeV excitation energy in both cases. The mean level spacings $D(J = 1/2)$ of these compound nuclei are determined to 0.2 keV for ^{55}*Mn and 0.07 keV for ^{57}*Co so that $\Gamma/D(J = 1/2) \approx 50 \gg 1$. (auth)

1788 ANGULAR CORRELATION MEASUREMENTS ON γ CASCADES FROM THE REACTION ^{57}Fe(n,γ)^{58}Fe. Schmidt, H.; Michaelis, W.; Fanger, U. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Phys., A136: 122-44(1969). (In German).

Within a study of the gamma radiation following thermal neutron capture in enriched ^{57}Fe(cross section 2.5 b), angular correlations of gamma-ray cascades were measured with NaI(Tl) scintillation detectors. By using a 2 × 1024 channel dual ADC connected to an on-line computer, more than 30 angular correlations could be determined simultaneously. Systematic errors arising from the coincident background under the peaks and from the complex structure of the capture spectrum were eliminated by application of the double-window technique. An extensive set of data was obtained which allows the mutually consistent determination of a large number of level spins and multipole mixtures of the transitions observed in ^{58}Fe. The contributions of the two possible capture state spins (0^- and 1^-) to the intensities of the primary transitions have been estimated for about 83% of the observed total intensity. Conclusions about the level structure and capture mechanism are briefly discussed. (auth)

1789 LIFETIMES OF THE FIRST TWO EXCITED STATES IN ^{29}P. Broude, C.; Karfunkel, U.; Wolfson, Y. (Weizmann Inst. of Science, Rehovoth, Israel). Nucl. Phys., A136: 145-52(1969).

The attenuated Doppler-shift method was used to measure the lifetimes of the first two excited states in ^{29}P produced in the ^{28}Si(p,γ) reaction. The measurements were analyzed using theoretical stopping cross sections. Values of 285 ± 80 fs and 290 ± 70 fs were obtained for the mean lifetimes of the 1381 and 1955 keV first and second excited states, respectively. Comparison with the corresponding levels in the mirror nucleus ^{29}Si shows strong similarities. The observed E2 enhancements in both nuclei indicate the importance of the ^{28}Si core. (auth)

1790 DETERMINATION OF THE SPIN OF THE 6.92 MeV LEVEL OF ^{25}Al. Duray, J. R.; Hausman, H. J.; Marshall, G. K.; Sinclair, J. W.; Steiner, W. S. (Ohio State Univ., Columbus). Nucl. Phys., A136: 153-9(1969).

The correlation geometry of Goldfarb and Seyler was employed in the ^{24}Mg(p,p'γ)^{24}Mg reaction for six laboratory proton energies between 4.7 and 5.3 MeV. A resonance observed in the correlation coefficients indicates a $5/2$ assignment to the 6.92 MeV state in ^{25}Al. (auth)

1791 LIFETIME OF THE ^{22}Na 3708 keV LEVEL. Warburton, E. K.; Carlson, L. E.; Garvey, G. T.; Hutcheon, D. A.; Jackson, K. P. (Nucl. Physics Lab., Oxford). Nucl. Phys., A136: 160-4(1969).

The mean lifetime of the ^{22}Na 3708 keV level was measured by the Doppler-shift attenuation method. The ^{19}F(α,n)^{22}Na reaction at alpha energies between 9 and 11 MeV was used to populate the state. Observations of gamma rays de-exciting the state were made using a Ge(Li) detector in singles and also as the center detector of a combination anti-Compton and pair spectrometer. A mean lifetime of 52 ± 17 fs was obtained. (auth)

1792 STUDY OF ^{82}Kr BY THE (α,p) REACTION. Walkiewicz, T. A.; Bleuler, E. (Pennsylvania State Univ., University Park). Nucl. Phys., A136: 177-82(1969).

The energy levels of ^{82}Kr were determined by the investigation of the ^{79}Br(α,p)^{82}Kr reaction, using 12.0-MeV alpha particles. The proton groups were recorded on nuclear track plates in a broad-range magnetic spectrograph. Spectra were obtained at laboratory angles of 20, 35, 50, 90 and 145°, and energy levels at 0, 775, 1476, 1815, 1956, 2098, 2430, 2485, 2551, 2656, 2844, 2950, 3015, 3077, 3183, 3320, 3360, 3445, 3589, 3643, 3681, 3733, 3837 and 3930 keV were found. This list contains all excited states proposed in recent studies of the decays of ^{82}Br and ^{82}Rb, with the exception of the 2172 keV level. (auth)

1793 CALCULATION OF EXCITATION ENERGY FOR CLUSTER LEVELS IN NUCLEI. Baz, A. I.; Zhukov, M. V.; Khrylin, B. A. (Inst. of Atomic Energy, Moscow). Yadern. Fiz., 10: 271-4(Aug. 1969). (In Russian).

Excitation energies of cluster threshold states in light nuclei ($20 \leq A \leq 60$) are calculated. (auth)

1794 BACKWARD PHOTOPROTON EMISSION FROM ^{27}Al. Costa, S.; Ferrero, L.; Garfagnini, R.; Piragino, G.; Zanini, A. (Univ., Turin. Istituto Nazionale di Fisica Nucleare, Turin). Nuovo Cim., Lett., 2: 336-8(Sept. 11, 1969).

The backward photoproton spectra from ^{27}Al were measured for $E_{\gamma\ max}$ = 85 MeV. The target was placed near the exit window of a diffusion cloud chamber which was in a magnetic field of 8 KG. The proton yield and spectra up to 20 MeV proton energies were measured at the 180° angle. (J.W.R.)

1795 ELECTRON ELASTIC SCATTERING ON THE ISOTOPES ^{58,60,64}Ni. Khvastunov, V. M.; Afanas'ev, N. G.; Afanas'ev, V. D.; Gul'karov, I. S.; Omelaenko, A. S.; Savitskii, G. A.; Khomich, A. A.; Shevchenko, N. G.; Romanov, V. S. (Physical-Technical Inst., Kharkov). Yadern. Fiz., 10: 217-24(Aug. 1969). (In Russian).

Measurements of the elastic scattering of the electrons with energy of 225 MeV on the isotopes ^{58,60,64}Ni are presented. It is established that the variation of the charge distributions for these nuclei may be explained with the effects of the neutron subshell filling. Comparing the values of the charge radii obtained when analyzing the electron elastic scattering and the transition energies in μ-mesoatoms, one concludes that the central charge density must be maximal in the Ni nucleus. (auth)

1796 PARITY NONCONSERVATION IN THE γ-DECAY OF ^{41}K. Lobashov, V. M.; Lozovoy, N. A.; Nazarenko, V. A.; Smotrizky, L. M.; Kharkevitsh, G. I. (Ioffe Inst. of Physics and Tech., Leningrad). Phys. Lett., 30B: 39-41(Sept. 1, 1969).

Parity non-conservation in nuclear forces was observed by measuring the circular polarization of the 1290 keV γ-transition in ^{41}K. The measured value of the circular polarization is $P = +(1.9 \pm 0.3) \times 10^{-5}$. (auth)

1797 THE RELATIVE SPATIAL DISTRIBUTIONS OF NEUTRONS AND PROTONS IN THE SURFACE OF ^{48}Ca. Bernstein, A. M.; Duffy, M.; Lippincott, E. P. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Lett., 30B: 20-2 (Sept. 1, 1969).

The elastic scattering of 31- and 28.9-MeV alpha particles from ^{40}Ca and ^{48}Ca was measured with high relative angular accuracy. The result is that the edge of the matter distribution (beyond the half density radius) in ^{48}Ca extends ≈0.15 fm beyond that of ^{40}Ca and is parallel in both nuclei. Combining this result with that of electron scattering, it is concluded, in agreement with theoretical calculations, that the neutrons have a larger spatial extent than the protons in the surface region of ^{48}Ca. (auth)

1798 INFINITE-DILUTION RESONANCE INTEGRALS OF ^{37}Cl AND ^{127}I. Brune, Dag (Aktiebolaget Atomenergi, Studsvik, Sweden). Radiochim. Acta, 12: 119-20(Aug. 1969).

The resonance integrals for ^{37}Cl and ^{127}I were determined by cadmium ratio measurements in a central position in a well moderated reactor, R1, with a well defined 1/E spectrum. Thin lead–gold foils (gold content: 0.1 mg/cm^2) were used as standards. The iodine samples consisted of 0.1 mg NH_4IO_3, and the chlorine sam-

ples of 0.4 mg NH_4Cl; all samples were diluted with 0.05 ml water. These samples were irradiated for periods of 1 min with and without 1 mm thick cadmium covers. The induced activities were assayed by means of gamma-spectrometry. (auth)

1799 INVESTIGATION OF ISOBARIC ANALOG RESONANCES ABOVE THE N = 50 SHELL WITH POLARIZED PROTONS. Wienhard, K.; Clausnitzer, G.; Graw, G.; Fleischmann, R. (Univ., Erlangen, Ger.). Z. Phys., 228: 129-42(1969). (In German).

In the region of isobaric analog resonances the analyzing power was measured in elastic scattering of polarized protons from the target nuclei ^{88}Sr, ^{90}Zr, ^{92}Zr, and ^{94}Zr. From the analysis of the energy and angular dependence spin and parity values were determined for 19 pronounced resonances, isobaric analog to states in ^{89}Sr, ^{91}Zr, ^{93}Zr, and ^{95}Zr. (auth)

1800 $^{15}N(^3He,d)^{16}O$ REACTION AND STRUCTURE OF ^{16}O. Fulbright, H. W. (Univ. of Rochester, N. Y.); Robbins, J. A.; Blann, M.; Fleming, D. G.; Plendl, H. S. Phys. Rev., 184: 1068-80(Aug. 20, 1969).

The structure of ^{16}O was studied by means of the $^{15}N(^3He,d)^{16}O$ reaction. The experiments were performed with 16.00- and 24.90-MeV ^3He beams from the tandem Van de Graaff accelerator. Reaction products were analyzed and recorded automatically by means of a high-resolution magnetic spectrometer equipped with a sonic-spark counter connected to an on-line computer system. In the region of excitation up to about 22 MeV, 14 lines were identified with levels of ^{16}O, all having odd parity except the ground state (which was strongly excited), the first excited state (which was weakly excited), and the third excited state (which was barely detectable). Many well-known states were not seen. The experimental data were analyzed by use of distorted-wave Born-approximation (stripping theory) calculations, and the results were compared with expectations from wave functions of the shell model and of the "mixed model" exemplified in the work of Brown and Green and of Kelson. The strengths of the transitions are mostly found to be in good agreement with predictions of the mixed model and, where applicable, the shell model, although the $J = 2^-$, $T = 0$ state at 12.53 MeV seems somewhat too strongly excited. However, a strongly excited state tentatively identified as a $J^\pi = 3^-$, $T = 0$ state of ^{16}O lying at 13.12 MeV is not predicted by any of the theories used in the comparisons. (auth)

1801 INVESTIGATION OF CONFIGURATIONS IN ^{46}Sc BY THE DIRECT $^{45}Ti(d,\alpha)^{46}Sc$ REACTION. Lewis, M. B. Univ. of Pittsburgh). Phys. Rev., 184: 1081-8(Aug. 20, 1969).

The angular distributions from the $^{45}Ti(d,\alpha)^{46}Sc$ reaction were measured at a deuteron beam energy of 17 MeV. The α particles were analyzed primarily by position-sensitive counters mounted in an Enge splitpole spectrograph with a typical experimental resolution of 15 keV full width at half-maximum for 20-MeV α particles. Distorted-wave Born-approximation calculations utilizing a microscopic form factor and including finite-range and nonlocal corrections produced reliable deuteron l-transfer distribution shapes. The experimental distributions indicate many unambiguous l transfers which determine parity and restrict possible J values for final states in ^{46}Sc. The relative strengths of the cross sections are subject to configuration effects through the 2s, 1d, 1f, and 2p nucleons which form the deuteron in the pickup process. In particular, states excited by $(f_{\frac{7}{2}})^2$, $(d_{\frac{3}{2}}f_{\frac{7}{2}})$, and possibly $s_{\frac{1}{2}}f_{\frac{7}{2}}$ and $(d_{\frac{3}{2}})^2$ pickup were identified. Of special interest is the population of the low-lying 6^+ state in ^{46}Sc, which can be quantitatively understood in terms of a ≈1% occupation probability for nucleons in the $1f_{\frac{7}{2}}$ shell of ^{45}Ti. (auth)

1802 EXPERIMENTAL TEST OF STATISTICAL-MODEL APPROXIMATIONS WHEN $\Gamma/D > 1$. Shaw, R. W. Jr.; Katsanos, A. A.; Vandenbosch, R. (Univ. of Washington, Seattle). Phys. Rev., 184: 1089-94(Aug. 20, 1969).

Cross sections were measured for the reaction $^{27}Al(p,\alpha)^{24}Mg$ to the ground and first six excited states of the residual nucleus at seven angles and in 30-keV steps over the proton laboratory energy region of 8 to 10 MeV. Average cross sections were calculated using formulas dependent on Hauser–Feshbach-model assumptions. Correlation functions for the statistical fluctuation of cross sections with energy were examined. The Hauser–Feshbach model and the Ericson fluctuation theory were found to be adequate to describe the average cross sections and cross-section fluctuations for both open and partially open exit channels. (auth)

1803 LOW-LYING NEGATIVE-PARITY STATES IN ^{21}Ne. Howard, A. J.; Pronko, J. G.; Whitten, C. A. Jr. (Yale Univ., New Haven). Contract AT(30-1)3223. Phys. Rev., 184: 1094-1101(Aug. 20, 1969).

Angular-distribution measurements were performed on the $^{22}Ne(p,d)^{21}Ne$ and $^{20}Ne(d,p)^{21}Ne$ reactions at $E_p = 20$ MeV and $E_d = 16.4$ MeV, respectively. In the $^{22}Ne(p,d)^{21}Ne$ reaction studies, formation of the 0-, 350-, and 3664-keV ^{21}Ne levels was characterized by respective $l_n = 2$, 2, and 1 neutron pickup transfers. The composite (p,d) angular distribution observed for the experimentally unresolved 2790- and 2796-keV states is shown to require a dominant $l_n = 1$ component in the associated distorted-wave Born-approximation fit, with evidence for a minor $l_n = 0$ component also being present. Since the 2796-keV level possesses $J^\pi = \frac{1}{2}^+$, the present (p,d) result implies $J^\pi = \frac{1}{2}^-$ or $\frac{3}{2}^-$ for the 2790-keV ^{21}Ne level. The $\frac{3}{2}^-$, 4730-keV state did not display discernible direct-reaction characteristics in this (p,d) study. This was also true of the remaining ^{21}Ne levels below $E_x = 5$ MeV, which generally possessed ~0.1-mb/sr cross sections attributed to second-order direct and/or compound nuclear-reaction mechanisms. The $^{20}Ne(d,p)^{21}Ne$ results indicate $l_n = 0$ transfer for the 2790-, 2796-keV ^{21}Ne composite, and $l_n = 1$ transfer for the 4730-keV ^{21}Ne state. The 3664-keV level did not display discernible direct reaction characteristics in this (d,p) study. The present findings establish that the major 1p-shell strength is located in the 2790- and 3664-keV ^{21}Ne levels, whereas the major $2p_{\frac{1}{2}}$ particle strength is associated with the 4730-keV ^{21}Ne state. These low-lying non-normal parity states are discussed within the framework of the Nilsson strong-coupling collective model. (auth)

1804 HYPERFINE STRUCTURE AND NUCLEAR MAGNETIC MOMENT OF ^{42}K. Chan, Yau W. (Brookhaven National Lab., Upton, N. Y.); Cohen, Victor W.; Silsbee, H. B. Phys. Rev., 184: 1102-4(Aug. 20, 1969).

The hyperfine structure in the $^2S_{\frac{1}{2}}$ electronic ground state of ^{42}K (12.4-h) was studied using a high-precision atomic-beam apparatus. The hyperfine separation is shown to be $\Delta\nu = 1\ 258\ 876\ 947\ (15)$ Hz. The nuclear magnetic dipole moment, measured independently of $\Delta\nu$, is $\mu_I = 1.142\ 4(2)\ \mu_N$. The hyperfine magnetic anomaly is evaluated as $_{39}\Delta_{42} = +0.000\ 3+0.003\ 36(38)$. (auth)

1805 MEAN LIVES OF STATES IN ^{27}Mg. McIntyre, L. C. Jr.; Carson, P. L.; Barker, D. L. (Univ. of Arizona, Tucson). Phys. Rev., 184: 1105-11(Aug. 20, 1969).

Mean lives of several low-lying states in ^{27}Mg were measured using the Doppler-shift-attenuation method. These levels, with measured mean lives, are 0.984 MeV [$\tau = (1.4 \pm 0.5) \times 10^{-12}$ sec], 1.69 MeV [$\tau = (1.3 \pm 0.5) \times 10^{-12}$ sec], and 1.94 MeV [$\tau = (1.4^{+0.6}_{-0.4}) \times 10^{-12}$ sec]. In addition, limits on the mean lives of the states at 3.48 and 3.56 MeV were obtained. The $^{26}Mg(d,p)^{27}Mg$ reaction with 2-MeV incident deuterons was used to populate levels in ^{27}Mg. The attempt to interpret the low-lying levels of ^{27}Mg in terms of the strong-coupling rotational model is met with conflicting evidence concerning the membership of the ground-state rotational band. (auth)

1806 INTENSITIES OF GAMMA RAYS FROM THE CALIBRATION SOURCE ^{56}Co. Scott, H. L.; Van Patter, D. M. (Franklin Inst., Swarthmore, Pa.). Phys. Rev., 184: 1111-16 (Aug. 20, 1969).

The intensities and energies of γ rays from 77.3-day ^{56}Co are especially useful for calibration of Ge(Li) detectors in the range 0.8 to 3.5 MeV. The ^{56}Co γ-ray spectrum was reexamined using a Ge(Li)–NaI(Tl) coincidence-anticoincidence spectrometer. This study revealed five previously unreported γ rays with energies of 896, 1140.2, 1336, 1443.2, and 1461.9 keV, all of which could be assigned to transitions from levels already established in the ^{56}Co decay. Other weak γ rays with energies of 2276.1, 2374.2, 2522.6, 3599.2, and 3612.5 keV were confirmed and their intensities were determined more accurately. A summary of the latest available data for the ^{56}Co decay is presented in the form of weighted averages for γ-ray energies and intensities and an improved decay scheme. (auth)

1807 DOPPLER-SHIFT MEASUREMENTS OF LIFETIMES OF LOW-LYING LEVELS IN ^{23}Na. Poletti, A. R. (Lockheed Palo Alto Research Lab., Palo Alto, Calif.); Jones, A. D. W.; Becker, J. A.; McDonald, R. E.; Nightingale, R. W. Phys. Rev., 184: 1130-5(Aug. 20, 1969).

Lifetimes of low-lying levels in ^{23}Na were measured using the Doppler-shift-attenuation method. Precise level energies were also deduced. The measured lifetimes or limits on lifetimes [E_x(MeV) τ_m(psec)] for a number of levels of ^{23}Na are 2.078 (<0.23), 2.391 (0.95 ± 0.20), 2.640 (0.20 ± 0.08), 2.705 (0.20 ± 0.10), 2.982 (<0.07), 3.678 (<0.17), 3.913 (<0.10). The decay properties of the 2.640- and 3.678-MeV levels are discussed in terms of the Nilsson model. (auth)

1808 DIRECTIONAL CORRELATION OF GAMMA RAYS IN ^{72}Ge. Monahan, W. G.; Arns, R. G. (Ohio State Univ., Columbus). Phys. Rev., 184: 1135-41(Aug. 20, 1969).

The γ rays of ^{72}Ge following the β decay of 14.1-h ^{72}Ga were studied using a 20-cm^3 Ge(Li) detector in coincidence with a 2 × 2-in. NaI(Tl) crystal. Directional-correlation measurements were carried out on the cascades involving 630-, 894-, 1231-, 2202-,

2491-, and 2508-keV γ rays with the 834-keV ground-state transition from the first excited 2+ state. 1-3 directional-correlation measurements (with the intermediate γ ray unobserved) were made between γ rays of energy 601, 786, 1000, 1051, 1215, 1597, and 1861 keV and the 834-keV transition. Spin assignments of 2 for the 1464- and the 3036-keV levels were confirmed. The 630- and 2202-keV transitions are nearly pure E2 and E1, respectively. The level of 2065 keV was assigned a spin of 3. The 601-keV transition has a maximum M1 admixture of 10%. Assuming that the 2515-keV level is a 3- state, the following spin and mixing assignments can be made. The level at 1728 keV is found to have a spin of 4, which requires 0.4 to 1.3% octupole mixture in the 894-keV transition. The levels at 3325 and 3342 keV have been assigned spins of 3 and 2, respectively. The 786-, 1597-, 2491-, and 2508-keV transitions are all nearly pure E1. (auth)

1809 LEVEL STRUCTURE OF ^{66}Ga. Bakhru, H.; Landenbauer-Bellis, I. M. (Yale Univ., New Haven). Phys. Rev., 184: 1142-53(Aug. 20, 1969).

The excited levels of ^{66}Ga were investigated from the decay of ^{66}Ge with high resolution Ge(Li) and Si(Li) detectors and with standard scintillation counters. ^{66}Ge was produced by the $(\alpha,2n)$ reaction on enriched ^{64}Zn. A chemical separation for Ge was performed. γ rays of the following energies (in keV) and intensities were assigned to the decay of ^{66}Ge: 44.3 ± 0.5 (70), 65 ± 0.5 (17), 91 ± 0.5 (2), 109.3 ± 0.5 (43), 125 ± 0.5 (1), 148 ± 0.5 (1), 155 ± 0.5 (<1), 168 ± 1 (≤1), 182 ± 0.5 (26), 190 ± 0.5 (25), 234.5 ± 1 (<1), 246 ± 0.5 (24), 272 ± 0.5 (40), 291 ± 1 (1), 303 ± 1 (10), 324 ± 1 (<1), 338 ± 1 (22), 382 ± 1 (100), 414 ± 1 (2), 428 ± 1 (2), 471 ± 1 (43), 493 ± 1 (3), 537 ± 1 (25), 574 ± 1 (1.5), 595.5 ± 1 (2.5), 638 ± 1 (3.5), 661 ± 1 (2.5), 705 ± 1 (21), 756 ± 1 (5), 821 ± 1 (~1), and 865 ± 1 (3) keV. The use of two Ge(Li) detectors in coincidence studies revealed the presence of several previously unreported transitions. Based on these results, a consistent level scheme of ^{66}Ga is given. The spin and parity assignments of some of the low excited levels of ^{66}Ga are discussed. The half-lives of the 44.3- and 109.3-keV levels were measured by delayed coincidence to be $(12 \pm 1) \times 10^{-9}$ sec and $(1.2 \times 0.2) \times 10^{-9}$ sec, respectively. (auth)

1810 THE RESIDUAL n–p INTERACTION IN ODD–ODD NUCLEI. Belousova, V. I.; Rudak, E. A. (Inst. of Physics, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk, No. 3, 94-6(1969). (In Russian).

The energy level spectra of the nuclei cobalt-56, niobium-92, and bismuth-210 are calculated in the j-j coupling approximation. (tr-auth)

1811 REACTION ^{48}Ca(n,γ)^{49}Ca WITH THERMAL NEUTRONS. Bogdanov, A. P.; Rudak, E. A.; Firsov, E. I. (Inst. of Physics, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk, No. 3, 97-101(1969). (In Russian).

The γ spectra from thermal neutron capture in ^{48}Ca was studied with a magnetic Compton spectrometer and a γ–γ scintillation spectrometer. The cross section was estimated from the data. (J.N.R.)

1812 DECAY OF ^{62}Co ISOMERS. Ward, T. E.; Pile, P. H.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). J. Inorg. Nucl. Chem., 31: 3023-38(Oct. 1969).

Five new γ-rays were found in the decay of 14.0 min ^{62}Co. Two new β-rays (1.20 MeV and 1.95 MeV) were observed and their coincidences measured. The 1.5 min isomer was found to decay with the following γ-rays: 1.128 ± 0.001, 1.172 ± 0.001, 2.299 ± 0.002, and 3.030 ± 0.004 MeV with relative intensities of 12.2 ± 0.3, 100.0, 41.1 ± 0.9, and 3.6 ± 0.06, respectively. β-rays of 2.90 ± 0.20 and 4.05 ± 0.15 MeV were observed. (auth) (UK)

1813 LIFETIMES OF LOW-LYING STATES IN ^{28}Si. Bister, M.; Anttila, A.; Raesaenen, J. (Univ. of Helsinki). Can. J. Phys., 47: 2539-43(Nov. 15, 1969).

The lifetimes of the four first excited energy levels of ^{28}Si were measured using the Doppler-shift attenuation method in the ^{27}Al(p,γ)^{28}Si reaction. In the analysis of the Doppler-shift data, the effect of the inelastic large-angle collisions in the slowing-down process was estimated in addition to the conventional treatment. (auth) (CANADA)

1814 EFFECT OF NATURE AND ENERGY OF AN INCIDENT PARTICLE ON THE RATIO OF THE FORMATION CROSS SECTIONS OF THE ISOMERIC STATES OF ^{134m,f}Cs AND ^{84m,f}Rb PRODUCED BY IRRADIATION OF LANTHANUM AND YTTRIUM TARGETS. Krupa, J. C.; Nguyen-Long-Den (Institut de Physique Nucleaire, Orsay, France). J. Inorg. Nucl. Chem., 31: 3011-17 (Oct. 1969). (In French).

A method for the separation of the alkali elements, carried out by means of an electromagnetic separator, is used to determine the ratios of the formation cross sections of isomeric states of ^{84}Rb and ^{134}Cs, produced respectively from ^{89}Y and ^{139}La targets bombarded with protons, deuterons, and alpha particles. Information on the various interaction mechanisms is obtained by studying the variation of these ratios with the energy of the incident particles. A qualitative interpretation of these results is given on the basis of the statistical model. (auth) (UK)

Nuclear Properties and Reactions, A ≥ 90

Refer also to abstracts 179, 492, 1511, 1621, 1721, 1732, 1769, 1774, 1778, 1779, 1781, 1786, 1798, 1799, 1810, 1814, and 1876.

1815 (COO-1265-73) COULOMB EXCITATION AND REORIENTATION OF THE OCTUPOLE STATE IN ^{208}Pb. Barnett, A. R.; Phillips, W. R. (Minnesota Univ., Minneapolis. John H. Williams Lab. of Nuclear Physics). [1969]. 55p. Dep. CFSTI.

The static quadrupole moment (Q) of the 2.614-MeV 3⁻ level in ^{208}Pb was measured by observing the angular distribution of inelastically scattered ^{4}He and ^{16}O ions following E3 Coulomb excitation. The reduced matrix element for the E3 transition from the ground state to the 3⁻ state, B(E3) ↑ was also obtained. Distributions were taken over the range 100 to 170°, using a multiple solid state detector array, at α particle energies of 19, 18, and 17.5 MeV, and at an oxygen energy of 69.1 MeV. Differential inelastic cross sections were in the range 10 to 40 μb/sr for α's and 200 to 300 μb/sr for oxygen. The 19-MeV data showed strong interference between the Coulomb excitation amplitude and an amplitude resulting from direct nuclear excitation. The remaining three sets of data showed no such interference and were analyzed simultaneously using the symmetrized semi-classical Coulomb excitation theory of Alder et al. The α data are not very sensitive to Q and yet are essential to the result, for the analysis of the α and oxygen data together limits the acceptable parameter range much more than if the oxygen data alone are used. (auth)

1816 (COO-1505-37) AVERAGE RANGES, CROSS SECTIONS, AND ISOMER RATIOS FOR THE ^{134}Ba(α,n)^{137m,g}Ce REACTION. Porile, N. T.; Swanson, D. G. (Purdue Univ., Lafayette, Ind. Dept. of Chemistry). Sept. 16, 1969. Contract AT(11-1)-1505. 24p. Dep. CFSTI.

Excitation functions, isomer ratios, and average recoil ranges were determined for the ^{134}Ba(α,n) reaction over the energy range from 15 to 28 MeV. The average ranges are compared with values predicted by Lindhard, Scharff, and Schiøtt on the assumption of compound nucleus formation and are found to be consistent with this mechanism over the energy range studied. The experimental isomer ratios and the excitation function agree well with the results of a spin-dependent statistical model calculation provided an energy-dependent moment of inertia is used. (auth)

1817 (COO-1505-38) ANGULAR DISTRIBUTIONS OF ^{137m}Ce AND ^{137g}Ce FROM THE ^{134}Ba(α,n) REACTION. Porile, N. T.; Swanson, D. G. (Purdue Univ., Lafayette, Ind. Dept. of Chemistry). Sept. 17, 1969. Contract AT(11-1)-1505. 27p. Dep. CFSTI.

The angular distributions of ^{137m}Ce and ^{137g}Ce nuclei formed in the ^{134}Ba(α,n) reaction were studied at three different energies in the range between 18 and 25 MeV. The results were compared to a spin-dependent statistical model calculation. Satisfactory agreement was obtained between theory and experiment at small angles. At large angles the calculated differential cross section was smaller than expected from the experimental data. The discrepancy can be attributed to a small contribution from a direct interaction mechanism. Average properties of the angular distributions were used to obtain the average values of the neutron and photon energies, and the difference in the values obtained for the two isomers was interpreted in terms of angular momentum effects. An angular distribution calculation for a hypothetical nucleus suggests that it may be possible to observe striking differences in the angular distribution of (α,n) reaction isomers due to spin fractionation. (auth)

1818 (IS-T-305) SILICON DETECTOR STUDIES OF NUCLEAR INTERNAL CONVERSION IN ^{155}Sm AND ^{151}Nd. Boneau, David Francis (Ames Lab., Iowa). May 1969. Contract W-7 7405-eng-82. 161p. Dep. CFSTI.

Thesis.

The intensities of conversion electrons from the decays of short-lived ^{155}Sm and ^{151}Nd were studied with a lithium-drifted silicon detector. The competing effects of continuous beta rays were reduced by requiring time coincidences between conversion electrons and beta rays. A system of monoenergetic response functions was employed to unfold the conversion electron spectra. Relative intensities were obtained for twenty conversion lines in the ^{155}Eu daughter and for thirty-seven in ^{151}Pm. Direct internal

conversion coefficient measurements found $\alpha_K = 0.235 \pm 0.020$ for the 104-keV transition in ^{155}Eu and $\alpha_K = 0.167 \pm 0.015$ for the 117-keV transition in ^{151}Pm. The present results were combined with gamma-ray intensities determined by others to produce internal conversion coefficients for many transitions in ^{155}Eu and ^{151}Pm. The conversion coefficients indicate that the low-lying levels in both nuclei consist of the first two members of the Nilsson $5/2 + [413]$, $5/2 - [532]$, and $3/2 + [411]$ bands. Conversion coefficients are reported for some transitions in ^{151}Pm that are not yet placed in the ^{151}Nd decay scheme. (auth)

1819 (JINR-P6-4553) ISOMERIC M4 TRANSITION IN ^{203}Po. Morek, T.; Noubert, W.; Droste, Ch.; Aleksander, K.; Chojnacki, S.; Wilhelmi, Z. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1969. 15p. (In Russian). Dep. CFSTI (U. S. Sales Only).

In the reactions ^{197}Au(^{11}B,5n)^{203}Po and ^{190}Os(^{18}O,5n)^{203}Po an isomeric transition with $E_\gamma = 640 \pm 1$ keV and $T_{1/2} = 1.2 \pm 2$ min was found. The multipolarity determined via conversion electron measurements is M4. (auth)

1820 (JINR-P6-4592) INVESTIGATION OF THE PROPERTIES OF THE NEUTRON DEFICIENT CESIUM NUCLEI. PART III. AN ISOMERIC STATE IN ^{123}Cs. Droste, Ch.; Noubert, W.; Morek, T.; Wilhelmi, Z.; Chojnacki, S.; Aleksander, K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1969. 13p. (In Russian). Dep. CFSTI (U. S. Sales Only).

A new isomeric state with gamma-transitions of 63 and 95 keV was found in ^{123}Cs. Multipolarities of both the transitions were determined: M1 + E2 or E2. The half-life is $T_{1/2} = 1.60 \pm 0.15$ sec. The isomeric state was excited in the reactions ^{115}In(^{12}C,4n)^{123}Cs and ^{109}Ag(^{18}O,4n)^{123}Cs. (auth)

1821 (JINR-P6-4615) NEW LEVELS OF ^{204}Bi FROM THE α-DECAY OF ^{208}At. Golovkov, N. A.; Ivanov, R. B.; Norseev, Yu. V.; Chumin, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1969. 9p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The α-decay of ^{208}At was investigated using a magnetic α-spectrometer. Besides the main α-transition three new transitions to the ^{204}Bi excited levels were observed. The energies of observed α-groups are given as well as their relative intensities and partial half-lives. On the basis of the available data the following excited levels of ^{204}Bi nucleus were introduced: 15, 56, 136 keV. (auth)

1822 (ORNL-4437, pp 1-19) NUCLEAR CHEMISTRY. (Oak Ridge National Lab., Tenn.).

Developments in various nuclear decay and reactor studies are reported. (J.W.R)

1823 (ORNL-4437, pp 20-39) CHEMISTRY AND PHYSICS OF TRANSURANIUM ELEMENTS. (Oak Ridge National Lab., Tenn.).

Research projects on thermal neutron capture and fission, decay studies, chemical properties, crystal structure, and preparation of the transuranium elements are summarized. (J.W.R.)

1824 INVESTIGATION OF THE STABILITY OF SUPERHEAVY NUCLEI AROUND Z = 114 AND Z = 164. Grumann, Jens; Mosel, Ulrich; Fink, Bernd; Greiner, Walter (Univ., Frankfurt am Main). Z. Phys., 228: 371-86(1969).

The potential-energy-surface was calculated using a method developed in a previous paper. Two regions of relative stability spontaneous fission around Z = 114 and Z = 164 are discussed in greater detail. The stability of the quasistable elements against fission is discussed and the stability against alpha- and beta-decay is estimated by using the mass formula of Myers-Swiatecki. It is found that quasistable elements should exist in the regions around Z = 114 and Z = 164. (auth)

1825 ADJUSTED NUCLEAR MASSES FOR $130 \leq A \leq 208$. Liran, S.; Zeides, N. (Hebrew Univ., Jerusalem). Nucl. Phys., A136: 190-228(1969).

Nuclear masses in the region $130 \leq A \leq 208$ were calculated by a least-squares adjustment of recent mass spectroscopic and nuclear data. Tables of the calculated masses and of the adjusted data are given. The consistency of the data and the accuracy of the resulting masses are discussed. (auth)

1826 THREE-QUASIPARTICLE STATES IN THE DECAY OF THE NEW ISOMER ^{181}Re. Conlon, T. W. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Phys., A136: 70-80(1969).

An isomeric state of ^{181}Re at 1877 keV with a half-life of 11.4 μsec was produced. The state is assigned a spin-parity of probably $15/2^-$ and decays by an M2 transition to a $13/2^+$ state which in turn decays through rotational members of a $K^\pi = 5/2^-$ band. Both states connected by the isomeric transitions are three quasiparticle states and differ only in the excitation of a single particle. (auth)

1827 THE K-SHELL INTERNAL CONVERSION COEFFICIENT OF THE 53-KeV GAMMA RAY OF ^{103}Rh. Sub, S. P.; Arora, B. K.; Trehan, P. N. (Panjab Univ., Chandigarh, India). Indian J. Pure Appl. Phys., 7: 441-2(June 1969).

The K-shell internal conversion coefficient (αK) of the 53-keV gamma ray of ^{103}Rh was measured by K X-ray peak to gamma peak method to be $\alpha K = 1.90 \pm 0.06$. This indicates a predominant M1 character with less than 1% E2 admixture for this gamma transition. (auth)

1828 THE GROUND-STATE SPIN OF ^{144}Pr. Rajput, M. S.; Sehgal, M. L. (Aligarh Muslim Univ., India). Indian J. Pure Appl. Phys., 7: 387-8(June 1969).

Angular correlation studies of the cascade 2296 keV (β)-696 keV (γ) of ^{144}Pr were performed to assign the ground state spin of ^{144}Pr. The integral $\beta-\gamma$ angular correlation function was found to be: $W(\theta,\beta-\gamma) = 1 + (0.4107 \pm 0.0621) P_2(\cos\theta) + (0.0131 \pm 0.0822) P_4(\cos\theta)$. The differential $\beta-\gamma$ angular correlation was also measured at six β-energy intervals. The experimental correlation coefficients were compared for possible spin values for the ground state of ^{144}Pr. A best fit of the data was obtained when the ground state spin of ^{144}Pr is taken to be O-. This assignment is also supported by theoretical considerations. (auth)

1829 MEASUREMENT OF THE NUCLEAR MAGNETIC MOMENT OF ^{110}Ag($T_{1/2}$ = 24.4s). Ackermann, H. (Univ., Heidelberg); Dubbers, D.; Mertens, J.; Winnacker, A.; von Blanckenhagen, P. Z. Phys., 228: 329-31(1969).

Nuclear magnetic resonance of ^{110}Ag was observed in silver halides using the polarized neutron capture, β decay anisotropy method. The magnetic moment was determined as $\mu_I(^{110}Ag) = 2.7084$ (5) nm (uncorrected). (auth)

1830 TABLES OF INTERNAL CONVERSION COEFFICIENTS FOR N-SUBSHELL ELECTRONS. Dragoun, O. (Max-Planck-Institut fuer Kernphysik, Heidelberg); Pauli, H. C.; Schmutzler, F. Nucl. Data, Sect. A, 6: 235-351(Sept. 1969).

Internal conversion coefficients are presented for the first five N-subshells for every value of the atomic number Z from Z = 60 to Z = 100. The coefficients are given for nuclear transition multipoles E1, . . . , E4, M1, . . . , M4 and for transition energies from about 1 keV above threshold to usually 500 keV. The finite nuclear size is taken into account as well as atomic screening according to the nonrelativistic, self-consistent field method. (auth)

1831 GIANT DIPOLE RESONANCE IN THE TRANSITION REGION FROM SPHERICAL TO DEFORMED NUCLEAR SHAPES. Vasilijev, O. V.; Zalesny, G. N.; Semenko, S. F.; Semenov, V. A. (Saratov State Univ., USSR). Phys. Lett., 30B: 97-9(Sept. 15, 1969).

The photoneutron cross sections of some nuclei in the N = 88-92 region have been measured. The results are compared with the predictions of the phenomenological dipole-quadrupole coupling model. (auth)

1832 ISOTOPIC-SHIFT PARAMETERS IN THE NILSSON MODEL. Cusson, R. Y. (Atomic Energy of Canada, Ltd., Chalk River, Ont.); Castel, B. Phys. Rev. Lett., 23: 871-4 (Oct. 13, 1969).

Fradkin's "compressibility under deformation" parameter ξ is calculated using the deformed Nilsson model of the nucleus. Numerical values in the range $-0.21 \leq \xi \leq +0.26$ are obtained for ^{62}Sm, ^{64}Gd, ^{70}Yb, and ^{92}U and for $-0.1 \leq \beta_\omega \leq +0.3$, to be compared with the empirical value $\xi \sim -0.2 \pm 0.1$. It is suggested that the effect comes from the saturation property of the nuclear force. (auth)

1833 THREE-FLUID HYDRODYNAMICAL MODEL AND THE PROTON DISTRIBUTION IN ^{208}Pb. Mohan, R.; Danos, M.; Biedenharn, L. C. (Duke Univ., Durham, N. C.). Phys. Rev. Lett., 23: 868-70(Oct. 13, 1969).

A three-fluid hydrodynamical model for nuclei is proposed and it is shown that the observed rise in proton density near the surface of ^{208}Pb can be accounted for in this model. (auth)

1834 ISOMER RATIOS OF ^{90}Y AND ^{91}Y IN THE FISSION OF ^{235}U AND ^{238}U BY PROTONS OF ENERGIES 20 TO 85 MeV. Khan, A. H.; Saha, G. B.; Yaffe, L. (McGill Univ., Montreal). Can. J. Chem., 47: 3817-22(Oct. 15, 1969).

Isomer ratios of ^{90}Y and ^{91}Y formed in the fission of ^{235}U and ^{238}U induced by protons of energies 20 to 85 MeV were determined. For both ^{90}Y and ^{91}Y the isomer ratios are always higher in ^{235}U fission than in ^{238}U fission. Isomer ratios of ^{90}Y in ^{238}U fission and those of ^{91}Y in ^{235}U and ^{238}U fission remain almost constant in the energy range of 20 to 85 MeV, whereas those of ^{90}Y in ^{235}U

fission increase with increasing bombarding energy. A theoretical calculation of these ratios indicates that the primary fragments leading to the formation of these isomers possess 2–3 ħ units of angular momentum. (auth) (CANADA)

1835 PHOTOPROTON REACTIONS THROUGH ISOBARIC ANALOG STATES IN ^{88}Sr AND ^{90}Zr. Shoda, K.; Sugawara, M.; Saito, T.; Miyase, H. (Tohoku Univ., Sendai). Phys. Rev. Lett., 23: 800-1(Oct. 6, 1969).

The photoproton cross sections of ^{88}Sr and ^{90}Zr for production of ground and low-energy residual states were measured. The results are in agreement with predictions of the particle-hole model for isobaric analog states. Strong and broad resonances are found around 21 MeV in ^{88}Sr and around 20 and 22 MeV in ^{90}Zr which agrees with coherent states expected by the theory. (auth)

1836 OBSERVATION OF THE $(g_{9/2})^2$ MULTIPLET IN ^{90}Nb VIA THE (^{3}He,t) REACTION. Bearse, R. C.; Comfort, J. R.; Schiffer, J. P.; Stautberg, M. M.; Stoltzfus, J. C. (Argonne National Lab., Ill.). Phys. Rev. Lett., 23: 864-6(Oct. 13, 1969).

Results are reported for angular distributions of the reaction ^{90}Zr(^{3}He,t)^{90}Nb at 21 MeV. It is found that for targets in the $f_{7/2}$ shell this reaction favors specific final states in which a neutron is replaced by a proton in the same shell-model orbit, coupled to any allowed angular momentum. The angular distributions differ in a systematic way depending on the spin of the final state. The nine states of the $T < (g_{9/2})^2$ multiplet are tentatively identified. A multipole decomposition leads to coefficients very similar to those of the $(f_{7/2})^2$ multiplet, showing an enhanced quadrupole coefficient. (auth)

1837 PROSPECTS IN THE SYNTHESIS OF NEW ISOTOPES AND ELEMENTS. Flerov, G. N. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 11-24 of Future of Nuclear Structure Studies. Vienna, International Atomic Energy Agency, 1969. (In Russian).

From Panel on Future of Nuclear Structure Studies, Dubna, USSR. See STI/PUB-220; CONF-680723.

The methods of new element production including neutron reactions, high energy proton reactions, heavy ion reactions, and fission from excited states, are considered. The possibility of existence of the region of stable super-heavy nuclei and methods of synthesizing various isotopes of elements with Z from 114 up to 126 are discussed. (auth)

1838 NUCLEAR g FACTORS OF THREE LEVELS OF ^{192}Pt. Kenyon, D. B.; Keszthelyi, L.; Cameron, J. A. (McMaster Univ., Hamilton, Ont.). Can. J. Phys., 47: 2395-9(Nov. 1, 1969).

The g factors of the 316, 612, and 785 keV levels of ^{192}Pt have been measured using gamma–gamma angular correlations perturbed by the hyperfine field in an iron alloy. Sources were ^{192}Ir in 1 at. % Ir Fe alloy. Coincidences were observed using a combination of Ge(Li) and scintillation detectors. For the three levels, the g factors obtained were 316 keV 2+ g = 0.30 ± 0.03, 612 keV 2+′ g = 0.28 ± 0.07, and 785 keV 4+ g = 0.14 ± 0.10. In addition, the E2/M1 mixing ratios obtained from the angular correlation measurements were 604 keV 3+ → 2+ δ = +3 ± 1, 308 keV 3+ → 2+′ δ = −9.4 ± 1.5, and 417 keV 4+ → 4+′ |δ| > 11. (auth) (UK)

1839 DETECTION OF NONRESONANT NEUTRON CAPTURE IN ^{207}Pb VIA THE THRESHOLD PHOTONEUTRON CROSS SECTION FOR ^{208}Pb. Bowman, C. D.; Baglan, R. J.; Berman, B. L. (Univ. of California, Livermore). Phys. Rev. Lett., 23: 796-800 (Oct. 6, 1969).

A nonresonant neutron-capture cross section was found in ^{207}Pb by measuring the asymmetry of a resonance in the threshold photoneutron cross section for ^{208}Pb. The magnitude of the nonresonant component is too large to be accounted for solely by the direct-capture mechanism of Lane and Lynn, but it might be accounted for by Brown's semidirect reaction mechanism. (auth)

1840 ELASTIC NEUTRON SCATTERING MEASUREMENTS ON ^{239}Pu IN THE ENERGY RANGE BETWEEN 0.19 AND 0.38 MeV. Knitter, H.-H.; Coppola, M. (EURATOM, Geel, Belgium). Z. Phys., 228: 286-94(1969).

Five neutron scattering angular distributions of ^{239}Pu were measured in the primary neutron energy range between 0.19 and 0.38 MeV. The absolute cross section results are presented in the form of coefficients of Legendre polynomial expansions. Integrated scattering cross sections are also given. Cross section calculations using a central optical model were made and their results were compared with the experimental values. (auth)

1841 INTEGRAL EXPERIMENT AND CROSS SECTIONS OF ^{239}Pu IN THE INTERMEDIATE ENERGY REGION. Hirota, Jitsuya; Kuroi, Hideo (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo), 6: 542-5(Sept. 1969).

Three different neutron spectrum cores, II-4, II-5, and II-2 with median fission energy of 0.2, 2, and 100 keV respectively, were assembled at the JAERI Fast Critical Facility (FCA), for carrying out an intermediate energy core program. Among the integral data measured in these cores, the central reactivity worths and fission rates of ^{239}Pu and ^{235}U in the II-5 and III-2 cores have been used to obtain information on the cross section of ^{239}Pu with the support of other integral data. Since a general description of the experiments performed has already appeared elsewhere, the evidence on the α-value of ^{239}Pu is examined. (auth)

1842 PROTON-CHANNEL ANALOG RESONANCES AND WEAK COUPLINGIN THE ^{205}Tl(d,p)^{206}Tl REACTION. Wharton, W. R.; Hinrichs, R. A.; Phillips, G. W.; Cramer, J. G. (Univ. of Washington, Seattle). Phys. Lett., 30B: 33-5(Sept. 1, 1969).

Proton resonance structure was observed in the ^{205}Tl(d,p) reaction at single-particle energies for outgoing protons leading to all strongly excited states below 3 MeV excitation in ^{206}Tl. Decay of the isobaric analog of the ^{207}Tl ground state was not observed. (auth)

1843 RESONANCE NEUTRON CAPTURE ON THE ^{141}Pr NUCLEUS. Urbanec, J. (Nuclear Research Inst., Rez, Czech.); Vrzal, J. Czech. J. Phys., B19: 1307-8(1969).

The spins and reduced neutron widths for resonances in ^{141}Pr neutron capture were determined from previous data on the low- and high-energy gamma quanta from the reaction. An improvement in the scheme of low-lying levels is seen. (J.W.R.)

1844 RELATIONS OF BRANCHING RATIOS AND RELATIVE INTENSITIES OF GAMMA RAYS FROM ^{105}Rh AND ^{106}Rh. Odru, P. (Centre d'Etudes Nucleaires, Grenoble, France). Radiochim. Acta, 12: 64-6(Aug. 1969). (In French).

Countings of the absolute β activity and of the gamma activity by means of precalibrated NaI crystals and junctions of various volumes, allowed determination of the branching ratios and the relative intensities of the different gamma rays in the spectra of ^{105}Rh and ^{106}Rh. (auth)

1845 FINE STRUCTURE IN NUCLEAR FISSION. PART II. YIELDS FROM 14.8 MeV NEUTRON INDUCED FISSION OF ^{231}Pa IN THE MASS REGION 131 TO 135. Birgul, O.; Lyle, S. J.; Sellars, J. (Kent Univ., Canterbury, Eng.). Radiochim. Acta, 12: 66-9(Aug. 1969).

The sum of the independent yields of ^{135}Xe and ^{135m}Xe and cumulative chain yields for masses 131 to 135 were measured radiochemically. Measurements were based upon the isolation and counting of iodine (131–134) and xenon (133 and 135) isotopes. Fine structure was observed at mass-134. The prominence of fine structure in the mass region 131–135 is compared with that obtained in 14-MeV neutron induced fission of ^{232}Th, ^{235}U, and ^{238}U. (auth)

1846 RADIOCHEMICAL DETERMINATION OF THE (n,2n) AND [(n,np) + (n,d)] CROSS SECTIONS OF ^{106}Cd AT 14.4 MeV. Lu, W.; Fink, R. W. (Georgia Inst. of Tech., Atlanta). Radiochim. Acta, 12: 61-4(Aug. 1969).

With radiochemical separations of ^{105}Ag from irradiated natural Cd targets at various times after the end of irradiation and with Ge(Li) detection, the ratio of the cross sections of the ^{106}Cd[(n,np) + (n,pn) + (n,d) ^{105}Ag and ^{106}Cd(n,2n)^{105}Cd reactions was determined to be 0.220 ± 0.023 which is independent of the decay scheme of ^{105}Ag and of the counting efficiency of the detector. Without chemistry, the cross section sum of the two reactions was determined to be 1190 ± 105 mb. From the ratio and the total cross section sum, the cross sections of the (n,2n) and the (n,np) + . . . reactions were found to be 975 ± 86 mb and 215 ± 29 mb, respectively, at 14.4 ± 0.3 MeV. (auth)

1847 STUDY OF DISINTEGRATION OF ^{169}Yb NUCLEUS. Miminoshvili, Z. N.; Murav'eva, V. V.; Sorokin, A. A. (Inst. of Nuclear Physics, Moscow). Yadern. Fiz., 10: 201-10(Aug. 1969). (In Russian).

The γ spectrum from ^{169}Yb was investigated by means of a Ge(Li) detector, as well as (in combination with a scintillator spectrometer) the γγ-coincidence spectra. A number of new γ transitions with the intensities of about 10^{-4} quanta per decay were detected, mainly in the energy region above 307.8 keV. Most of these transitions may be placed in a disintegration scheme previously presented. The scheme is supported also by the coincidence measurements. However a number of data indicate to an uncertainty of the identification of the 336-keV level in ^{169}Tm (as well as, apparently, of the levels 368 and 640 keV) as states in the basic rotational band with $K^\pi = 1/2^+$. (auth)

1848 ROTATIONAL AND QUASI-ROTATIONAL SPECTRA IN EVEN-EVEN NUCLEI IN THE "NEW REGION OF DEFORMATION." Wilhelmi, Z. (Inst. of Nuclear Research, Warsaw. Warsaw Univ.). Fortschr. Phys., 17: 189-203(1969).

A review is presented of studies on the region of static nuclear deformation for which both N and Z lie within the range 50 to 82. Some of the experimental techniques are described and the present status of experimental research is evaluated. The data on the rotational and quasi-rotational states of the even isotopes of xenon, barium, and cerium are discussed in detail. (J.W.R.)

1849 ALTERATION OF THE β DECAY PROBABILITY BY PHYSICO-CHEMICAL MEANS. Kemeny, P. (Inst. for Atomic Physics, Bucharest). Radiochem. Radioanal. Lett., 2: 41-6 (Sept. 26, 1969).

The results of two independent half-life measurements of ^{131}I are presented. Both, carried out by slightly different γ scintillation techniques, yielded a decreased half-life of ^{131}I in crystalline NaI with respect to its aqueous solution. This fact, which means that the environment affects the β-decay probability is explained qualitatively by the changing or screening correction, or the effective nuclear charge or both. The half-life alteration of solid xenon with respect to the gaseous state is presented, together with a qualitative explanation. (auth)

1850 THE SPECTROSCOPIC NUCLEAR ELECTRIC QUADRUPOLE MOMENT OF ^{159}Tb. Klinkenberg, P. F. A.; Dekker, J. W. M. (Univ., Amsterdam). Physica, 43: 92-4(July 1, 1969).

The hyperfine interaction constants were determined for the $4f^8 6s$ configuration of Tb. Using the value obtained for the electric quadrupole interaction constant and assuming pure L-S coupling, the nuclear electric quadrupole moment of ^{159}Tb was calculated. A value of Q = 1.18 barns was obtained. (J.W.R.)

1851 SOME PROPERTIES OF γ EMISSION ACCOMPANYING SPONTANEOUS FISSION OF ^{252}Cf. Val'skii, G. V.; Aleksandrov, B. M.; Baranov, I. A.; Krivokhatskii, A. S.; Petrov, G. A.; Pleva, Yu. S. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 10: 240-7(Aug. 1969). (In Russian).

Intensities and spectra were measured of γ emission at angles of 30 and 90° to the axis of separation of fragments during the times less than $\sim 2 \times 10^{-8}$ sec in spontaneous fission of ^{252}Cf. The dependence of the yield and value of the γ emission anisotropy on the total kinetic energy of fragments is obtained. It is found that for γ quanta with the energy $E_\gamma \gtrsim 100$ keV the yield fluently decreases while the anisotropy somewhat increases with the total kinetic energies of fragments. The dependence of anisotropy on the γ quanta energy is also obtained. The results of the experiment are discussed within existing concepts on angular momenta and the character of excited states of fragments. (auth)

1852 FISSION OF ^{226}Ra BY NEUTRONS IN THE THRESHOLD REGION. Babenko, Yu. A.; Ippolitov, V. T.; Nemilov, Yu. A.; Selitskii, Yu. A.; Funshtein, V. B. Yadern. Fiz., 10: 233-9(Aug. 1969). (In Russian).

The complex behavior of the Ra fission cross section in the region of threshold values of the neutron energy is found. The step-wise increase of σ_f is supposed to be due to the existence of two fission barriers: 8.3 MeV for states with negative parity and 9.4 MeV for states with the positive parity. Diagrams of angular distribution of the Ra fission fragments in the energy region E_n = 3.6 to 7.1 MeV are given. In the region of the first sharp increase of σ_f the channel structure of the fission barrier is explicitly seen. Analysis of the form of angular distribution of fragments results in the conclusion that with the increase of excitation energy the channels with the parameters of K^π $1/2^-$, $3/2^-$, $1/2^-$ are most observable. (auth)

1853 DETERMINATION OF NUCLEAR AMPLITUDES OF W ISOTOPE SCATTERING USING NEUTRONGRAPHIC METHOD. Aleksandrov, Yu. A.; Balagurov, A. M.; Malishevski, E.; Machekhina, T. A.; Sedlakova, L. N.; Kholas, Ya. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 10: 328-35(Aug. 1969). (In Russian).

Using the method of neutron diffraction on powders and monocrystals, the nuclear amplitudes of the scattering of W isotopes were measured (^{182}W, ^{183}W, ^{184}W, ^{186}W). Due to the interference of potential and resonance scattering, the ^{186}W isotope amplitude was found to be negative and anomalously small. This fact opens possibilities for investigation of effects of screening by strong nuclear interaction, particularly, for precise measurement of interaction between neutron and electron. (auth)

1854 INSTANTANEOUS FISSION NEUTRONS. Pick-Pichak, G. A. (Inst. of Atomic Energy, Moscow). Yadern. Fiz., 10: 321-7(Aug. 1969). (In Russian).

Possible evaporation of neutrons from not fully accelerated ^{252}Cf fission fragments is studied. It is shown that this process can essentially contribute to the experimentally observed isotropic in l. s. part of the fission neutrons. (auth)

1855 DETERMINATION OF THE HALF-LIFE OF ^{108m}Ag BY MEANS OF (n,2n)-CROSS SECTIONS OF SILVER. Vonach, H. (Technische Hochschule, Munich); Hille, M.; Hille, P. Z. Phys., 227: 381-90(1969). (In German).

The half-life of ^{108m}Ag was determined as (310 ± 132) years by measuring the absolute activity of a sample containing a known number of ^{108m}Ag nuclei. This could be done by evaluating the cross section for the production of the isomer $\sigma^{109}Ag(n,2n)^{108m}Ag$ = (670 ± 266) mb. From the measured half-life a log ft-value of 8.9 for the electron capture decay of the isomer to the 1770 keV state of ^{108}Pd and a transition probability of $(1.0 \pm 0.4) \cdot 10^{-2}$ Weisskopf units for the M4 transition to the 2^--state of ^{108}Ag were derived. The cross section for thermal neutrons $^{107}Ag(n,\gamma)^{108m}Ag$ could be calculated to be (7.5 ± 3.2)b by using a related measurement from the literature. (auth)

1856 SHELL MODEL CALCULATION OF THE SEPTUPLET IN ^{209}Bi. Arita, K.; Horie, H. (Tokyo Inst. of Tech.). Phys. Lett., 30B: 14-15(Sept. 1, 1969).

The shell model study was carried out about the close septuplet of ^{209}Bi without assuming weak particle-vibration coupling. The energies and the wave functions of these states are discussed. (auth)

1857 GIANT DIPOLE RESONANCE FOR THE NUCLEUS ^{181}Ta. Ishkhanov, B. S.; Kapitonov, I. M.; Lazutin, E. V.; Piskarev, I. M.; Shevchenko, O. P. (Moscow State Univ.). JETP Lett. (USSR) (Engl. Transl.), 10: 51-3(July 20, 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu, 10: 80-4(July 20, 1969).

The neutron photoproduction cross section for ^{181}Ta was studied at threshold to 30 MeV. The measurements were made in 0.1-MeV steps and the photoneutrons were registered with a detector of 0.45 efficiency. The total photoneutron cross section corrected for the multiplicity $\sigma(\gamma, n) + \sigma(\gamma, np) + \sigma(\gamma, 3n)$ was obtained. The results were compared with predictions of the hydrodynamic model. (J.W.R.)

1858 QUADRUPOLE AND OCTUPOLE EXCITATIONS OF EVEN TIN ISOTOPES BY ELECTRON SCATTERING. Curtis, T. H.; Eisenstein, R. A.; Madsen, D. W.; Bockelman, C. K. (Yale Univ., New Haven). Contract No. (30-1)2726. Phys. Rev., 184: 1162-77(Aug. 20, 1969).

Form factors obtained by the inelastic scattering of 60-MeV electrons from the first 2^+ and 3^- collective states of ^{116}Sn, ^{118}Sn, and ^{120}Sn are reported. The momentum transfer range covered is 0.3 to 0.6 F^{-1}. Reduced transition probabilities B(EL) and transition radii R_{tr}^2 are extracted from the data, using a transition charge distribution with a radial dependence given by the derivative of a Fermi charge distribution, and the distorted-wave code DUELS. In addition, the parameters c and t for a ground-state Fermi charge distribution, obtained by elastic scattering, are reported for ^{116}Sn, ^{118}Sn, ^{120}Sn, and ^{124}Sn. (auth)

1859 MAGNETIC MOMENT OF ^{145}Sm AND ATTENUATION FOLLOWING THE DECAY OF ORIENTED ^{145}Sm. Kaplan, Morton; Blok, J.; Shirley, D. A. (Univ. of California, Berkeley). Phys. Rev., 184: 1177-80(Aug. 20, 1969).

Samarium-145 nuclei were oriented at low temperatures in neodymium ethylsulfate (NES) and cerium magnesium nitrate (CMN) lattices. From the temperature-dependent angular distribution of the 61-keV γ ray in ^{145}Pm, a magnetic moment μ = 0.92 ± 0.06 μ_N was deduced for the ground state of ^{145}Sm. The ratio of attenuation coefficients in the 61-keV state of ^{145}Pm in the two lattices was found to be $G_2(CMN)/G_2(NES) = +0.44(10)$. Evidence is presented which indicates that temperature gradients in CMN can lead to erroneously low values for magnetic moments. (auth)

1860 NUCLEAR ORIENTATION AND REORIENTATION STUDIES WITH ^{147}Nd. Barrett, Paul H.; Shirley, D. A. (Univ. of California, Berkeley). Phys. Rev., 184: 1181-4(Aug. 20, 1969).

The results of new nuclear orientation measurements on ^{147}Nd and reanalysis of old data in light of the revised temperature scale for neodymium ethylsulfate (NES) are presented. Previously assigned spins in ^{147}Pm are confirmed, while several γ-ray mixing ratios are altered somewhat, and the previously reported L = 0 character of several β branches is found to be incorrect. Auxiliary experiments in cerium magnesium nitrate (CMN) give further support to the new NES temperature scale. The attenuation factors of the 91-keV level in ^{147}Pm were determined for the two lattices to be $G_2(91)_{NES} = 0.89 \pm 0.11$ and $G_2(91)_{CMN} = 0.42 \pm 0.12$. The latter is in poor agreement with Daniels and Misra's theoretical values. Available data on reorientation following decay of oriented nuclei in paramagnetic salts are summarized, and are interpreted as indicating dependences on both environment and intermediate-state lifetime. (auth)

1861 INTERPRETATION OF SOME NEUTRON STATES FOR A = 140 TO 150. Barrett, Paul H.; Shirley, D. A. (Univ. of California, Berkeley). Phys. Rev., 184: 1185-8(Aug. 20, 1969).

Nuclear states at 122 and 198 keV are populated in the decay of ^{147}Pm to ^{147}Sm. The 742-keV state of ^{143}Nd is reassigned to be $\frac{3}{2}^-$. Neutron states of $\frac{3}{2}^-$ and $\frac{1}{2}^-$ character are traced through the region A = 140–150. The $\frac{3}{2}^-$ state (the ground state in ^{143}Ce) is interpreted, for N = 85 and 87, as a quasiparticle (qp)-plus-phonon state, predicted by Kisslinger and Sorensen. The $\frac{5}{2}$ state (ground state in ^{147}Nd) is interpreted as either their qp-plus-phonon state or as a three-qp intruder state. A diagnostic rule for the identification of three-qp states—that their magnetic moments appear in the "wrong" Schmidt group—is discussed and applied to ten cases (auth)

1862 Ge(Li)–Ge(Li) STUDY OF THE ^{134}I DECAY. Winn, W. G.; Sarantites, D. G. (Washington Univ., St. Louis). Contract Nos. AT(11-1)-1530; AT(11-1)-1760. Phys. Rev., 184: 1188–1200(Aug. 20, 1969).

The levels in ^{134}Xe were investigated from the decay of 53-min ^{134}I by means of Ge(Li) γ-ray spectrometry. From γ-ray energy and intensity measurements employing a high-resolution Ge(Li) detector, and from coincidence relationships determined by γ-γ coincidence measurements using two Ge(Li) detectors, it was established that levels at 846.95, 1613.4, 1731.0, 1919.8, 2136.3, 2271.7, 2303.0, 2352.8, 2408.5, 2547.4, 2588.1, 2653.1, 2773.4, 2867.3, 3084.3, 3256.0, 3300.8, 3314.4, 3359.9, 3375.3, 3475.6, and 3493.0 keV are populated in the decay of ^{134}I. Possible levels at 2704.7, 3160.4, 3190.0, 3463.1, 3790.3, and 3874.5 keV are discussed on the basis of energy sums. From the log ft values obtained, limits for the J^π values of many levels in ^{134}Xe were placed. No evidence for the population of the 7^- isomer of ^{134}Xe was found in ^{134}I decay. (auth)

1863 NUCLEAR-STRUCTURE STUDIES IN Mo AND Nb ISOTOPES VIA STRIPPING REACTIONS AT 12 MeV. Moorhead, J. B.; Moyer, R. A. (Univ. of Pittsburgh). Phys. Rev., 184: 1205–16(Aug. 20, 1969).

Proton energy spectra from (d,p) reactions induced by 12-MeV deuterons on targets of ^{92}Mo, ^{94}Mo, ^{96}Mo, and ^{93}Nb were measured with 7–9 keV resolution. Angular distributions of proton groups in the spectra were used to determine the l values of the transitions yielding the respective proton groups. In reactions on the Mo isotopes, all of the expected strength is found for transitions leading to $s_{\frac{1}{2}}$, $d_{\frac{3}{2}}$, and $d_{\frac{5}{2}}$ states. In contrast with the situation in the isotonic Zr isotopes, where no $h_{\frac{11}{2}}$ states are known, one $h_{\frac{11}{2}}$ state is found in each odd-A Mo isotope; however, in each case the excitation strength is only a small fraction of the expected total for that level. The total excitation strength for the $g_{\frac{9}{2}}$ level is also far below the expected total, and there is no evidence that this level is filling in the Mo isotopes as neutrons are added. In ^{94}Nb, values of I for several members of the $(\pi g_{\frac{9}{2}})$ $(\nu d_{\frac{5}{2}})$ and $(\pi g_{\frac{9}{2}})$ $(\nu g_{\frac{9}{2}})$ configurations are estimated from sum rules and the presence of mixing. (auth)

1864 ELASTIC AND INELASTIC SCATTERING OF 20.3-MeV POLARIZED PROTONS FROM ^{90}Zr, ^{92}Zr, AND ^{92}Mo. Glashausser, C. (Univ. of California, Berkeley); de Swiniarski, R.; Goudergues, J.; Lombard, R. M.; Mayer, B.; Thirion, J. Phys. Rev., 184: 1217–25(Aug. 20, 1969).

The elastic and inelastic scattering of polarized protons from ^{90}Zr, ^{92}Zr, and ^{92}Mo was studied at 20.3 MeV. Asymmetries for the first 2^+ states in ^{90}Zr and ^{92}Mo are very similar; the ^{92}Zr 2^+ asymmetry is quite different from these, especially at large angles. The asymmetry for the first 3^- state in ^{92}Zr resembles the ^{90}Zr–^{92}Mo 3^- data more closely. Microscopic-model calculations for the 2^+ states with and without core-polarization contributions give poor fits to the asymmetry data, through cross sections are well fitted. Macroscopic-model calculations with the full Thomas form of the deformed spin-orbit potential give a better fit to the 2^+ data and quite closely predict the 3^- asymmetries. (auth)

1865 ^{252}Cf HALF-LIFE BY NEUTRON COUNTING: REVISION. de Vopi, A.; Porges, K. G. (Argonne National Lab., Ill.). Inorg. Nucl. Chem. Lett., 5: 699(Aug. 1969).

Reference is made to the authors' communication in Inorg. Nucl. Chem. Letters 5: 111(1969), in which a disintegration constant of $(7.212 \pm 0.017) \times 10^{-4}$/day was reported for ^{252}Cf by neutron counting. Discrepancies were found in the neutron calibration procedure adopted. The new value is $(7.239 \pm 0.016) \times 10^{-4}$/day, corresponding to a half-life of 957.5 ± 2.1 days or 2.621 ± 0.006 yr. (UK)

1866 CUMULATIVE YIELDS OF TIN AND ANTIMONY NUCLIDES FROM THERMAL-NEUTRON FISSION OF ^{235}U. Erdal, B. R.; Williams, J. C.; Wahl, A. C. (Washington Univ., St. Louis). Contract AT(11-1)-1162. J. Inorg. Nucl. Chem., 31: 2993–3003(Oct. 1969).

The following cumulative fission yields were measured and are reported: 27.06-hr ^{121}Sn, 0.0122 ± 0.0008%; ~60-yr ^{121}Sn, 0.0019 ± 0.0006%; 127-day ^{123}Sn, 0.0019 ± 0.0001%; 9.67-day ^{125}Sn, 0.0116 ± 0.0004%; ^{125}Sb, 0.0291 ± 0.0015%; 2.1-hr ^{127}Sn, 0.067 ± 0.008%; ^{127}Sb, 0.103 ± 0.004%; ^{128}Sn, 0.314 ± 0.019%; ^{128}Sb, 0.62 ± 0.03%. These yield values are compared with those previously published, and average or recommended values are used with considerations of nuclear charge division to derive the following chain yields for the indicated mass numbers: 121, 0.0140 ± 0.0010%; 123, 0.0160 ± 0.0012%; 125, 0.027 ± 0.003%; 127, 0.103 ± 0.004%; 128, 0.36 ± 0.06%; 129, 0.63 ± 0.04%. It has been determined that 82.6 ± 0.9% of ^{127}Sb decays to 9.3-hr ^{127}Te and that 83.4 ± 1.1% of ^{129}Sb decays to 68.7-min ^{129}Te. (auth) (UK)

Nuclear Theory

Refer also to abstracts 517, 1499, 1677, 1743, 1756, 1767, 1774, 1793, 1832, 1833, and 1861.

1867 (COO-1746-26) ANGULAR DISTRIBUTIONS OF CONVERSION ELECTRONS. Steffen, R. M. (Purdue Univ., Lafayette, Ind. Dept. of Physics). Aug. 11, 1969. Contract AT(11-1)-1746. 91p. (CONF-690818-4). Dep. CFSTI.

From International Conference on Radioactivity in Nuclear Spectroscopy, Nashville, Tenn.

The angular (directional and polarization) distribution of internal conversion electrons emitted from oriented nuclear states is discussed. The oriented nuclear states may be produced by low temperature orientation, by nuclear reactions or by the observation of a preceding radiation (angular correlation). A survey of the theory of the conversion electron particle parameters which characterize the angular distributions of conversion electrons is presented and the influence of penetration effects and of EO transitions on the angular distributions is discussed. (auth)

1868 (STI/PUB-220) FUTURE OF NUCLEAR STRUCTURE STUDIES. Panel Proceedings Series. Proceedings of a Panel Held in Dubna, [USSR], 1–3 July 1968. (International Atomic Energy Agency, Vienna (Austria)). July 1969. 172p. (In English and Russian). (CONF-680723). IAEA $5.00. Dep.

Separate abstracts were prepared for 10 of the 12 papers included. (J.W.R.)

For abstracts of individual papers see: 495, 517, 521, 1837, and 1883–1888.

1869 QUADRUPOLE MOMENT OF ^{6}Li GROUND STATE. Gunye, M. R. (Tata Inst. of Fundamental Research, Bombay). Phys. Lett., 30B: 64–6(Sept. 15, 1969).

The observed small negative quadrupole moment of J = 1, T = 0 ground state of ^{6}Li is explained by a band-mixing projection calculation for this state which is found to contain a large admixture of two close-lying intrinsic states of the nucleus. (auth)

1870 COMMENTS ON A SINGLE SEPARABLE POTENTIAL WITH ATTRACTION AND REPULSION. Beam, J. E. (Rice Univ., Houston, Tex.). Phys. Lett., 30B: 67–70(Sept. 15, 1969).

Tabakin's recent nucleon–nucleon potential overbinds the triton by 300 MeV. This unfortunate result is attributed to existence of an undesired zero-width resonance in this potential. The potential provides insight, however, into the 3-boson bound-state energy spectrum. (auth)

1871 CORRELATED CHARGE FORM FACTORS OF p-SHELL NUCLEI. Gerace, W. J.; Sparrow, D. A. (Princeton Univ., N. J.). Phys. Lett., 30B: 71–4(Sept. 15, 1969).

Electron scattering form factors for p-shell nuclei are calculated including short range correlations in a finite well shell model basis. Dependence of the form factor on the strength of the correlations is found to be more important than variations of the well geometry. For Woods–Saxon wells with geometries from optical model results and well depths determined by single particle separation energies, the inclusion of correlations improve agreement with experiment. (auth)

1872 THEORETICAL APPROACH TO THE (p,2p) REACTIONS ON LIGHT NUCLEI. Kolybasov, V. M.; Smorodinskaya, N. Ya. (Inst. for Theoretical and Experimental Physics, Moscow). Nucl. Phys., A136: 165–76(1969).

The (p,2p) reactions on light nuclei are investigated theoretically at small momentum transfer. The contribution of the pole graph whose singularity in momentum transfer is the nearest to the physical region was explicitly written. The total contribution of the other graphs, which are slowly varying functions of the momentum transfer, is approximated by a constant. The spin structure of the additional term is taken to correspond to the triangle graph with rescattering of the final protons on the nucleus. The

theoretical differential cross sections are compared with the available experimental data at 155, 185 and 460 MeV. The proton reduced widths of the light nuclei, obtained from the (p,2p) reactions at different energies, are compared both with each other and with the results obtained from (n,d), (d,n) and (π^-, π^-n) reactions. The calculated results are in good agreement with the experimental data. (auth)

1873 A COMPARISON BETWEEN VELOCITY- AND DENSITY-DEPENDENT INTERACTIONS IN FINITE NUCLEI CALCULATIONS. Koehler, H. S.; Lin, Y. C. (Univ. of Arizona, Tucson). Nucl. Phys., A136: 35-48(1969).

A comparison is made between Hartree–Fock calculations utilizing a velocity-dependent interaction of quadratic form and an interaction in which the velocity dependence is converted to a density dependence. The conversion is made so that it is exact for nuclear matter. For finite nuclei considerable differences between the two interactions occur when computing density distributions and energy spectra of level states. Total binding energies also give errors of 1.5 MeV/A for ^{16}O and 1.0 MeV/A for ^{40}Ca, while for ^{208}Pb the error is negligible. It is suggested to approximate the general non-locality or velocity dependence of the Brueckner K-matrix by a quadratic velocity dependence. This should be preferred to a density dependence as it is less drastic, but no more difficult to compute with. (auth)

1874 MIXING BETWEEN SIMPLE AND COMPLICATED STATES AND IDENTIFICATION OF DOORWAY STATES. Jeukenne, J. P. (Univ., Liege); Mahaux, C. Nucl. Phys., A136: 49-69(1969).

The configuration mixing between a simple state and complicated states is first studied in a standard bound-state model. Various methods have been used in the past, which lead to different theoretical laws. The conditions of validity and the compatibility of these laws are critically examined. Some treatments are extended to the case of a small spreading width. The theoretical predictions are compared with the results of a numerical example. It is shown that the observable quantities (reduced widths, transition probabilities, ...) usually display asymmetric distributions. The connection with the scattering problem is established. The analysis and interpretation of experimental data are discussed. It is emphasized that there always exist many possible interpretations of the experimental results. It is exhibited that the analysis of the fine structure is not relevant to the identification of a doorway state. In the one-channel case, any cross section can always be interpreted as corresponding to the existence of a single doorway state. The examples of the reactions ^{56}Fe(n,n) and ^{208}Pb(n,n) are discussed. (auth)

1875 INTERMEDIATE STATES IN FISSION. Bjoernholm, S.; Strutinsky, V. M. (Univ. of Copenhagen). Nucl. Phys., A136: 1-24(1969).

Shell effects give rise to modulations in the liquid-drop fission barriers. For heavy nuclei with neutron number in the vicinity of 146–148, a two-humped barrier results, and the states of the secondary minimum act as intermediate states in the fission process. The existence of such states is reflected in subbarrier fission induced by neutrons in the resonance region, in the occurrence of broad resonance structures in the fission excitation functions, in anomalous fragment angular distributions and in the observed fission isomerism. Theoretical consequences of a two-humped fission barrier are developed and compared with experiment. (auth)

1876 CORIOLIS INTERACTION BETWEEN OCTUPOLE STATES IN THE EVEN Dy ISOTOPES. Neergard, K.; Vogel, P. (Univ. of Copenhagen). Phys. Lett., 30B: 75-8(Sept. 15, 1969).

The results of RPA calculations of the octupole states are used as a basis for a Coriolis coupling problem. Matrix elements $\langle K+1|J_+|K\rangle$ are calculated. For collective states $|K\rangle$ and $|K+1\rangle$ these nearly approach the spherical limit $\sqrt{(3-K)(3+K+1)}$. Inclusion of the Coriolis coupling improves the agreement between theory and experiment considerably. Particularly, it is able to explain the experimental B(E3) values. (auth)

1877 SINGLE-PARTICLE STATES FOR ASYMMETRIC FISSION. Wong, C. Y. (Univ. of Copenhagen). Phys. Lett., 30B: 61-3(Sept. 15, 1969).

Single-particle states for two overlapping ellipsoids of different sizes and shapes are evaluated. Their application to fission is discussed. (auth)

1878 CHARGE FORM FACTOR AND QUADRUPOLE MOMENT OF ^{6}Li. Cheon, Il-T. (IAEA, Trieste, Italy). Phys. Lett., 30B: 81-4(Sept. 15, 1969).

A new model is proposed which can produce the charge form factor and the quadrupole moment. Theoretical results are in good agreement with the experimental data. (auth)

1879 THE ^{12}C–^{12}C REACTIONS AND THE ALPHA-PARTICLE MODEL. Michaud, G. (California Inst. of Tech., Pasadena); Vogt, E. W. Phys. Lett., 30B: 85-7(Sept. 15, 1969).

It is suggested that the ^{12}C–^{12}C reactions are one of a number of related phenomena in light nuclei manifesting alpha-particle structure rather than shell structure. A model for the reactions is outlined and experiments are proposed. (auth)

1880 EQUILIBRIUM THEORY OF THE SYMMETRY ENERGY OF FINITE NUCLEI. Weiss, R. A.; Cameron, A. G. W. (Yeshiva Univ., New York). Can. J. Phys., 47: 2211-54(Oct. 15, 1969).

The nuclear symmetry energy of finite nuclei is calculated first in a nonequilibrium scheme in which the binding energy is a function of the central density parameter as well as the mass number and neutron excess parameter, i.e., $E(k_{cE},A,\xi)$, and then in an equilibrium scheme with the central density parameter given as a function of A and ξ in the form $k_{cE}(A,\xi) = k_{c0}(1 + q_1\xi - q_2\xi^2 + q_3\xi^3 - q_4\xi^4 + \ldots)$, where $k_{c0} = k_\infty(1 + \rho_0)f^{-1}$ and the $q_j(A)$ and $\rho_0(A)$ depend on Coulomb and surface effects. In the equilibrium scheme, the symmetry energy coefficients are functions of mass number. A connection is made between the symmetry energy coefficients as calculated in the nonequilibrium (NE) and equilibrium schemes, and these coefficients were found to be, $\beta_0(A) = \beta_0^{NE}(k_{c0})$, $\beta_2(A) = \beta_2^{NE}(k_{c0}) - \frac{1}{2}q_1^2K_0^2$, etc. The fourth order coefficient $\beta_4(A)$ is large and negative for all A, and is about –47 MeV in the region $A \approx 125$ which agrees reasonably well with the –37 MeV value predicted by the Cameron–Elkin exponential mass formula. No linear term is found in the symmetry energy, but third, fifth, and higher order odd symmetry energy coefficients are found to be present. The alternation of the signs of the symmetry energy coefficients as well as the density expansion coefficients are in accordance with Le Chatelier's principle. As in the case of infinite nuclear matter, the binding energy of nuclei with neutron excess is larger than that calculated assuming constant density, and that a negative isospin compression energy must be added to the constant density calculation of the energy if the correct binding is to be predicted. Finally, the general expression for the symmetry energy coefficients of order j is $\beta_j(A) = C_0^j + \Sigma_{\nu=1}^{\infty}(C_\nu^j A^{\nu/3} + d_\nu^j A^{-\nu/3})$. (auth) (CANADA)

1881 EQUILIBRIUM THEORY OF THE NUCLEAR SYMMETRY ENERGY OF INFINITE NUCLEAR MATTER. Weiss, R. A. (Yeshiva Univ., New York); Cameron, A. G. W. Can. J. Phys., 47: 2171-2209(Oct. 15, 1969).

A set of generalized nuclear matter curves is calculated as a function of density and $\xi = 1 - (2Z/A)$, which maps out the energy versus density plane for $0 \le \xi \le 1$ and determines the nuclear matter equilibrium curve (NMEC) as the locus of their saturation points. The NMEC immediately determines the equilibrium energy and density as a function of the neutron excess, and thereby automatically gives the nuclear symmetry energy. The component parts of the equilibrium energy are also determined, and we find that the average kinetic energy per nucleon is a decreasing function of the neutron excess parameter, so that the contribution of the kinetic energy to the second order coefficient, β_2^{∞}, is negative. By noting that the density variation along the NMEC is determined by $k_{FE} = k_\infty(1 - F_2\xi^2 + F_4\xi^4 - \ldots)f^{-1}$ with $k_\infty = 1.4$ f^{-1}, $F_2 \sim 0.45$, and $F_4 \sim 0.07$, we find a general connection between the equilibrium and nonequilibrium symmetry energy coefficients, i.e., $\beta_0^{\infty} = \beta_0^{NE}(k_\infty)$, $\beta_2^{\infty} = \beta_2^{NE}(k_\infty)$, $\beta_4^{\infty} = \beta_4^{NE}(k_\infty) - \frac{1}{2}F_2^2K_0^{(2)}$, etc., where $K_0^{(2)}$ is the standard nuclear compressibility. We find a large negative value for the fourth order coefficient, $\beta_4^{\infty} \sim -25$ MeV, and a large positive value for the sixth order coefficient, $\beta_6^{\infty} \sim 15$ MeV, while the corresponding nonequilibrium values of these two coefficients are small and positive. Nuclear matter systems with neutron excess are found to be more bound than is predicted by constant density calculations, and we find that a negative isospin compression energy term is required to be added to the previous constant density calculations. (auth) (CANADA)

1882 ISOSPIN SUM RULES IN NUCLEAR PHYSICS. Leonardi, Renzo (Univ., Bologna); Rosa-Clot, Marco. Phys. Rev. Lett., 23: 874-7(Oct. 13, 1969).

A systematic analysis of the electric dipole sum rules in the different isospin channels is given. The connections between these sum rules and the well-known old ones are classified. A simple application is given in resolving the isospin components of the nuclear giant resonance. (auth)

1883 THEORETICAL PROBLEMS IN NUCLEAR STRUCTURE. Brown, G. E. (State Univ. of New York, Stony Brook). pp 87-97 of Future of Nuclear Structure Studies. Vienna, International Atomic Energy Agency, 1969.

From Panel on Future of Nuclear Structure Studies, Dubna, USSR. See STI/PUB-220; CONF-680723.

Problems concerning the nucleon-nucleon interaction, interac-

tions off-the-energy shell, and the use of effective interactions in calculation of nuclear spectra are discussed. (auth)

1884 INTERMEDIATE STRUCTURE EFFECTS IN NEUTRON-INDUCED FISSION CROSS-SECTIONS. Rae, E. R. (United Kingdom Atomic Energy Authority, Harwell, Eng.). pp 115-23 of Future of Nuclear Structure Studies. Vienna, International Atomic Energy Agency, 1969.

From Panel on Future of Nuclear Structure Studies, Dubna, USSR. See STI/PUB-220; CONF-680723.

The intermediate structure in the fission cross-sections are discussed in relation to the spontaneously fissioning isomers. (auth)

1885 PROBLEMS OF THE DEVELOPMENT OF NUCLEAR PHYSICS IN SMALL COUNTRIES (AS EXEMPLIFIED BY CZECHOSLOVAKIA). Trlifaj, L. (Nuclear Research Inst., Prague). pp 133-8 of Future of Nuclear Structure Studies. Vienna, International Atomic Energy Agency, 1969.

From Panel on Future of Nuclear Structure Studies, Dubna, USSR. See STI/PUB-220; CONF-680723.

Czechoslovakia is treated as typical of the smaller European industrial countries and the country's difficulties in keeping abreast of nuclear physics developments are summarized. Ways in which the smaller countries can play their part in the development of nuclear physics are suggested. (auth)

1886 ROLE OF INTERNATIONAL SCIENTIFIC CENTRES IN PROMOTING NUCLEAR RESEARCH IN DEVELOPING COUNTRIES. Sodnom, N. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 139-43 of Future of Nuclear Structure Studies. Vienna, International Atomic Energy Agency, 1969.

From Panel on Future of Nuclear Structure Studies, Dubna, USSR. See STI/PUB-220; CONF-680723.

Economically underdeveloped countries are primarily interested in research work which will yield an immediate economic effect. However, such work can be successful only if based on a sound theoretical scientific foundation, and this cannot be attained without developing fundamental research. For the developing countries, nuclear physics, with the rich promise attending the use of its results, is one of the most desirable branches of fundamental research. The development of theoretical physics is of importance too since it contributes greatly to raising the level of experimentation and university and secondary school teaching. Scientific research, however, particularly in nuclear physics, comes up against great difficulties in underdeveloped countries, e.g., limited finances, a weak technological infrastructure, shortage of qualified scientists, and a low level of training. The problem of making progress in nuclear physics in developing countries may partially be solved by participation in international research centers. This possibility is discussed on the basis of experience obtained by the Joint Nuclear Research Center at Dubna. (auth)

1887 CONTRIBUTION TO THE PROPOSAL FOR THE FORMATION OF REGIONAL CENTRES FOR NUCLEAR PHYSICS IN THE DEVELOPING COUNTRIES. Alaga, G. (Inst. Rudjer Boskovic, Zagreb). pp 145-9 of Future of Nuclear Structure Studies. Vienna, International Atomic Energy Agency, 1969.

From Panel on Future of Nuclear Structure Studies, Dubna, USSR. See STI/PUB-220; CONF-680723.

The development of nuclear physics in developing countries is discussed, pointing out the difficulties of research in the future. A proposal for the formation of regional centers is put forward. Arguments justifying the formation of these regional centers are presented together with the suggestion that UNESCO and IAEA act as sponsors and financial supporters of the regional centers. The institutes in the developing countries could serve as a basis for such centers. Countries which are qualified and interested in having and using the facilities of the regional centers should also participate in the financing of them. (auth)

1888 SOME DEVELOPMENTS IN OUR APPROACHES TO NUCLEAR STRUCTURE PHYSICS. Wilkinson, D. H. (Nuclear Physics Lab., Oxford). pp 25-44 of Future of Nuclear Structure Studies. Vienna, International Atomic Energy Agency, 1969.

From Panel on Future of Nuclear Structure Studies, Dubna, USSR. See STI/PUB-220; CONF-680723.

The evolution of traditional approaches, including accelerators and on-line techniques are discussed, and new approaches involving elementary particles and high-energy methods are described. (auth)

1889 FRACTIONAL PARENTAGE COEFFICIENTS FOR THE ORBITAL WAVE FUNCTION OF NUCLEI IN THE UNITARY SYMMETRY SCHEME. II. THE METHOD OF CALCULATION FOR THE TWO-PARTICLE FRACTIONAL PARENTAGE COEFFICIENTS. Petrauskas, A. K.; Sabalyauskas, L. Yu.; Vanagas, V. V. (Inst. of Physics and Mathematics, Vilnyus, USSR). Liet. Fiz. Rinkinys, Liet. TSR Mokslu Akad., Liet. TSR Aukst. Mokyklos, 9: 39-60(1969). (In Russian).

The method of calculation of the two-particle fractional parentage coefficients for the nuclear wave function in the unitary symmetry scheme is discussed. The numerical tables of one- and two-particle coefficients for ground and excited $U_{3(n-1)}$ states for $3 \leq n \leq 7$ are presented. (auth)

1890 FRACTIONAL PARENTAGE COEFFICIENTS FOR THE ORBITAL WAVE FUNCTION OF NUCLEI IN THE UNITARY SYMMETRY SCHEME. III. THE METHOD OF CALCULATION FOR THE CLUSTER-TYPE FRACTIONAL PARENTAGE COEFFICIENTS. Sabalyauskas, L. Yu.; Petrauskas, A. K.; Vanagas, V. V. (Inst. of Physics and Mathematics, Vilnyus, USSR). Liet. Fiz. Rinkinys, Liet. TSR Mokslu Akad., Liet. TSR Aukst. Mokyklos, 9: 61-71(1969). (In Russian).

The method of calculation for the cluster-type fractional parentage coefficients for the nuclear wave function in the unitary symmetry scheme is outlined. The numerical tables of the fractional parentage coefficients separating two- and three-particle wave functions in the ground and excited $U_{3(n-1)}$ nucleus states for $4 \leq n \leq 7$ are presented. (auth)

1891 $\alpha-\alpha$ INTERACTION POTENTIAL CORRECTION IN ACCORDANCE WITH THE VIBRATIONAL EXCITED STATE USING THE α-MODEL OF NUCLEI. Pipiraite, P. P.; Shugurov, V. K. (Pedagogical Inst., Vilnyus, USSR. Vilnyus State Univ., USSR). Liet. Fiz. Rinkinys, Liet. TSR Mokslu Akad., Liet. TSR Aukst. Mokyklos, 8: 775-82(1968). (In Russian).

An $\alpha-\alpha$ potential, valid at large distances between α-particle is extended to smaller distances. Yukawa type repulsion is introduced depending on a parameter which is calculated from the 0^+ vibrational state of a number of nuclei having α-model structure. (auth)

1892 FRACTIONAL PARENTAGE COEFFICIENTS FOR THE ORBITAL WAVE FUNCTION OF NUCLEI IN THE UNITARY SYMMETRY SCHEME. I. RELATIONSHIPS BETWEEN VARIOUS TYPES OF FRACTIONAL PARENTAGE COEFFICIENTS. Petrauskas, A. K.; Sabalyauskas, L. Yu.; Vanagas, V. V. (Inst. of Physics and Mathematics, Vilnyus, USSR). Liet. Fiz. Rinkinys, Liet. TSR Mokslu Akad., Liet. TSR Aukst. Mokyklos, 8: 721-36 (1968). (In Russian).

Fractional parentage coefficients for the orbital nuclear wave function in the unitary symmetry scheme are discussed. Relationships between various types of fractional parentage coefficients, suitable for calculating the matrix elements of one- and two-particle operators are obtained. Some useful connections for calculating the one-particle coefficients and some numerical tables of these coefficients for the ground $U_{3(n-1)}$ nuclei states for $n \leq 16$ are presented. (auth)

1893 THE SIGN OF THE PRODUCT OF THE REDUCED MATRIX ELEMENTS OF E2 TRANSITIONS BETWEEN THE O^+, 2^+, AND 2_2^+ STATES IN EVEN-EVEN NUCLEI. Isakov, V. I.; Lemberg, I. Kh. (Ioffe Inst. of Physics and Tech., Leningrad). JETP Lett. (USSR) (Engl. Transl.), 9: 438-41(June 20, 1969).

Translated from Zh. Eksp. Teor. Fiz., Pisma Redaktsiyu, 9: 698-702(June 20, 1969).

It is shown that the sign of the product of the reduced matrix elements of E2 transitions between the 0^+, first 2^+, and second 2^+ states in even-even nuclei can be obtained within the framework of Davydov's phenomenological theory without resorting to nuclear reaction data. An estimate is made for the sign of this product for ^{114}Cd. (J.W.R.)

1894 AVERAGING METHODS IN NUCLEAR REACTION THEORY. Moldauer, P. A. (Argonne National Lab., Ill.). Phys. Rev. Lett., 23: 708-11(Sept. 29, 1969).

It is pointed out that statistical calculations and averages involving overlapping resonances require the use of averaging intervals that are small compared with the energy interval containing the resonance sample. Averages taken over the entire resonance sample or more are physically inappropriate and lead to incorrect relations. (auth)

1895 CONTRIBUTION TO THE THEORY OF RESONANCE REACTIONS IN THE REGION OF OVERLAPPING LEVELS. Kudryavtsev, A. E. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 10: 309-14(Aug. 1969). (In Russian).

A formula describing the energy dependence of the reaction amplitude is obtained. It is shown that the width of the giant resonance in the region of overlapping levels differs from the sum of the partial widths in terms that are nonlinear on the level density. (auth)

1896 TWO-PHONON STATES IN DEFORMED NUCLEI. Solov'ev, V. G. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 10: 296-8(Aug. 1969). (In Russian).

Properties of two-phonon states in even–even deformed nuclei are discussed and retardation of their population in β decays is estimated, necessary search for two-phononic states is taken into account. (auth)

1897 PHENOMENOLOGICAL THEORY OF COLLECTIVE EXCITATIONS IN NUCLEI. Rabotnov, N. S.; Seregin, A. A. Yadern. Fiz., 10: 286-95(Aug. 1969). (In Russian).

Dependence of the potential energy of a deformed nucleus on the deformation parameters is discussed. It is shown that the potential of the form $V = A + B\beta + C\beta^2 + D\beta \cos 3\gamma$ is practically useful. A method is presented for numerical solution of the Schroedinger equation of the collective model with five dynamical variables for such a potential, without assuming a smallness of the vibrations about the equilibrium deformation or their adiabatic separation from the rotations. Positions of the levels 0^+, 2^+, 4^+, 6^+ are calculated and compared with the experimental data on even–even nuclei. (auth)

1898 ENERGY LEVELS IN TWO- AND THREE-NUCLEON SYSTEMS WITH YUKAWA-TYPE POTENTIAL IN STRONG-COUPLING APPROACH. Simenog, I. (Inst. of Physics, Kiev). Yadern. Fiz., 10: 281-5(Aug. 1969). (In Russian).

Explicit dependence of energy levels on the coupling constant g is obtained for two nucleons interacting via a Yukawa-type potential (singular at zero), by means of the strong-coupling approach. The method is extended to the case of an arbitrary potential. Binding energy for three nucleons is calculated for the Yukawa and Hulthen potentials, that is in good agreement with numerical calculations by means of the factorization method. (auth)

1899 SELFCONSISTENT CALCULATIONS OF THE NUCLEAR CHARGE DISTRIBUTIONS. Gorodkov, S. S.; Nemirovskii, P. E. (Inst. of Atomic Energy, Moscow). Yadern. Fiz., 10: 275-80(Aug. 1969). (In Russian).

Selfconsistent calculations of the charge-density distributions in intermediate and heavy nuclei, are fulfilled on basis of the empirical relation between the nuclear matter density and the shell potential. The values of the charge rms radii calculated with a unified set of parameters deviate from the experimental values no more than by 2%. Varying the parameters one is able to obtain the charge distributions in the isotopes of Ca that are close to those found in recent experiments with 750-MeV electrons. (auth)

1900 INTERACTION OF ONE-PARTICLE AND ROTATIONAL MOTIONS IN NUCLEI. Chernei, M. I.; Ovsyannikov, V. D. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 10: 262-70(Aug. 1969). (In Russian).

The Coriolis interaction is diagonalized based on the one particle scheme of the deformed Saxon–Woods potential. One spin-independent parameter, i.e., moment of inertia, is used to describe rotational bands. Solutions obtained are used to analyze the energies of rotational bands and the behavior of the decoupling parameter inside a rotational band as well as to analyze probabilities of K-forbidden β transitions and divergence from the Alaga rules. (auth)

1901 STABILISING EFFECTS OF SHELLS IN POSITIONS OF EXCITED NUCLEAR LEVELS AND THE STRUCTURE PARAMETERS OF THE NEUTRON STRENGTH FUNCTION. Sukhoruchkin, S. I. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 10: 251-61(Aug. 1969). (In Russian).

Complex analysis of the data on the position of the excited levels for a large class of nuclei confirms the stabilizing effect, with the range of several dozens of keV, that was found before. Grouping effects with the same magnitude appear also at higher (3–6 MeV) excitation energies. Superposing a small interval (30 keV) upon the one-particle interval ($\epsilon_0 = 1.02$ MeV) one is able to describe the grouping effects in the neutron binding energies and in the positions of neutron levels for light and intermediate nuclei. It follows from the nonstatistical shape of the neutron-level distributions that for a correct determination of practically important quantities, such as the neutron strength functions, one needs to have the measurement, or the averaging interval to be more than the characteristic period (30 keV) of the grouping effects found. (auth)

1902 ON THE CONNECTION OF THE EFFECTIVE PARTICLE–HOLE FORCE AND THE SINGLE-PARTICLE POTENTIAL IN A MICROSCOPIC THEORY. Gross, D. H. E. (Hahn-Meitner-Inst. fuer Kernforschung, Berlin). Phys. Lett., 30B: 16-19(Sept. 1, 1969).

The phenomenological ansatz given by Satchler and Moszkowski of a surface peaked effective particle-hole force to be used in standard shell-model calculations and in the DWBA is justified microscopically in any order of perturbation theory. (auth)

1903 PREDICTED PROPERTIES OF THE FISSION OF SUPERHEAVY NUCLEI. Nix, J. R. (Los Alamos Scientific Lab., N. Mex.). Phys. Lett., 30B: 1-4(Sept. 1, 1969).

For the fission of the super-heavy nucleus $^{298}114$ it is estimated that the total energy release per fission should be 317 MeV, the average number of neutrons $\bar{\nu}$ should be 10.5, and the average neutron laboratory kinetic energy should be 2.8 MeV. These and similar results for other super-heavy nuclei are substantially larger than the corresponding values for conventional fissile nuclei. (auth)

1904 RELATION BETWEEN NUCLEAR MATRIX ELEMENTS FOR FIRST-FORBIDDEN BETA-DECAYS. Fayans, S. A.; Khodel, V. A. (Atomic Energy Inst., Moscow). Pys. Lett., 30B: 5-7(Sept. 1, 1969).

Methods of the finite Fermi-systems theory are used to obtain the relation between $\int\alpha$ and $\int$ir. (auth)

1905 NUMBER-CONSERVING SETS AND THIRD-ORDER RENORMALIZATION CONTRIBUTIONS TO THE EFFECTIVE NUCLEAR INTERACTION. Barrett, B. R. (Univ. of Pittsburgh); Kirson, M. W. Phys. Lett., 30B: 8-10(Sept. 1, 1969).

The simplest third-order number-conserving set of diagrams, which represents the renormalization of the bare reaction matrix G, is computed for A = 18 nuclei using the Kuo G matrices. As predicted by Brandow, the sum of terms within this set is found to be small, being 10% of G or less. (auth)

1906 GROUND-STATE CORRELATIONS AND EXTENSION OF THE SINGLE-PARTICLE PICTURE IN LIGHT NUCLEI. Suzuki, Kenji (Kyushu Inst. of Tech., Fukuoka). Bull. Kyushu Inst. Technol., Math., Natur. Sci., No. 16, 39-58(Mar. 1969).

A new theory of treating the ground-state correlations and the corresponding renormalization effects is proposed. In the theory, two-particle-two-hole and four-particle-four-hole excitations are taken up as the important parts in the ground-state correlations. The correlated true ground state is given through multiplication of the unitary operator to the Hartree–Fock ground state. The unitary operator is determined from the condition of minimizing the energy of the correlated true ground state. New single-particle operators are defined through the unitary transformation of the Hartree–Fock single-particle operators in the second-quantization formalism. The transformed Hamiltonian represented by the new single-particle operators is established to display the renormalization effects in the single-particle energies and the two-body matrix elements, and further it is proved that in the Hamiltonian the two-body interactions inducing the ground-state correlations are reduced to small and negligible values. With the Hamiltonian, we are led to a simple situation where the correlated shell-model states can be solved by the usual Tamm–Dancoff method on the new single-particle basis. As an example of the theory, a unified treatment of the correlated odd- and even-parity states in the closed-shell nuclei are discussed. (auth) (NSA of Japan)

1907 PHYSICS OF HEAVY IONS. Deconninck, G. (Univ., Namur, Belgium). Rev. Quest. Sci., 140: 341-58(July 1969). (In French).

Two aspects of heavy-ion physics are considered: the study of nuclear structure itself, and the production of new isotopes, particularly trans-U isotopes. Sub-Coulomb and transfer reactions are noted briefly; specificity of reactions supplies a field for theoreticians. Spectroscopic studies would be of advantage in studying the aggregates found in transfer reactions. Problems of acceleration are outlined, particularly with respect to synthesis of trans-U isotopes. The preparation of $^{310}Z_{126}$ from ^{160}Gd and ^{150}Sm is suggested in preference to a route from ^{80}Kr. A division at 8 MeV/nucleon is made, above which point the problems are more of interest to astrophysicists than to nuclear physicists. Even the very heavy isotopes currently sought can be of no more than curious interest, except in the elaboration of the cosmic-ray problem. It is possible that developments in astronomical studies will parallel those in nuclear research, softening the question of increasing expense for accelerators. (BBB)

1908 YADERNAYA FIZIKA. TOM I. PREVRASHCHENIYA YADER I ATOMNAYA OBOLOCHKA. (Nuclear Physics. Vol. I. Nuclear Transformation and Nuclear Shell). Romanov, A. M. (ed.). Tashkent, Akademiya Nauk Uzbekskoi SSR, 1969. 472p.

The problems of radioactive nuclear transformation related to the atomic shell, (internal γ-ray conversion, electron capture, etc.) the effects of the shell on the life time, angular correlation of nuclear emission, and nuclear orientation are discussed in the first three chapters. The neutrino and the law of β-interactions are covered in the fourth chapter. Data of excitation and atomic ionization are covered in the fifth chapter. Atomic ionization during α decay and nuclear fission and the practical use of the kinetic and

electronic atomic activation during nuclear transformations are investigated in the sixth and seventh chapters. The supplements deal with certain physical constants, the electron distribution in free atomic levels, energy of K- and α boundary absorption and corrections for screening for resolved β spectra. Tabulated coefficients of internal γ ray conversion on K-shells and for internal conversion on α subshell are included. (523 references.) (R.V.J.)

1909 ISOSPIN SUM RULES AND PHOTODISINTEGRATION OF THE A = 3 NUCLEI. O'Connell, J. S. (National Bureau of Standards, Washington, D. C.); Prats, F. Phys. Rev., 184: 1007-12(Aug. 20, 1969).

Three sum rules for the electric dipole photodisintegration cross section of the A = 3 nuclei are split into their final-state isospin components. The isospin doublet contribution to the three-nucleon breakup mode is estimated to be of the order of 10 to 20% and originates primarily in the high-energy region. (auth)

1910 INDEPENDENT-PARTICLE-MODEL ENERGY-LEVEL FORMULA. Miller, L. D.; Green, A. E. S. (Univ. of Florida, Gainesville). Phys. Rev., 184: 1012-17(Aug. 20, 1969).

The Morse function is assumed to approximate a nonlocal or velocity-dependent nucleon-nuclear potential. Analytic neutron and proton wave functions and eigenvalue formulas are obtained for all states of all nuclei, using a modified version of an analytic perturbation method due to Pekeris. The eigenvalue formula is in approximate agreement with the following experimental data: (1) the last-particle binding energies of neutrons and protons, (2) the neutron and proton magic numbers, (3) the positions of the S-wave-size resonances in total-neutron-cross-section data, and (4) the recent experimental work on deeply bound inner particle states by Amaldi et al. The eigenvalue formula gives results that are consistent with recent Hartree-Fock calculations. (auth)

1911 CHARGE-DEPENDENT NUCLEAR FORCES AND DAMPING OF ANALOG STATES. Mekjian, A. Z. (Rutgers-The State Univ., New Brunswick, N. J.). Phys. Rev., 184: 1031-4(Aug. 20, 1969).

The spreading width of an analog state due to a charge-dependent nuclear force is calculated. The mixing with the surrounding different-isospin states via the configuration states and also direct mixing are investigated. The restrictions imposed by the requirement of charge symmetry on these mixings are discussed. The mixing arising from a charge-asymmetric force is also calculated. (auth)

1912 ON THE TEST OF THE GENERALIZED PAULI PRINCIPLE FOR COMPLEX NUCLEI IN NUCLEAR REACTIONS. von Oertzen, Wolfram (Max-Planck-Institut fuer Kernphysik, Heidelberg). Z. Phys., 228: 182-7(1969).

The conditions for the symmetry of the angular distributions of nuclear reactions leading to two members of an isospin multiplet are discussed. It is shown that the test of the symmetry of the angular distribution about 90° involves a test of the isospin symmetry of a specific decomposition of the nuclei and of the two members of the iso-multiplet participating in the rearrangement collision. (auth)

1913 PION ELECTROPRODUCTION FROM NUCLEI. Moniz, E. J. (Stanford Univ., Calif.). Contract No. F44620-68-C-0075. Phys. Rev., 184: 1154-61(Aug. 20, 1969).

Detailed understanding of hadron production in nuclei is important for nuclear physics, for the study of hadron-nucleon interactions, and for quantum-electrodynamic experiments involving nuclear targets. The double differential electron-nuclear cross section is calculated for the region of electron energy loss corresponding to excitation of the first nucleon resonance, using a Fermi-gas model of the nucleus. This simple model allows one to reach an analytic expression for the cross section and to tie directly onto the Czyz-Walecka threshold calculation. Further, the quasielastic scattering is calculated in exactly the same nuclear model to indicate the reliability of this approach. Since the results here are model-dependent, such experiments should allow some insight into the nuclear physics. (auth)

1914 STATISTICAL THEORY OF (n,γ) AND (p,γ) EXCITATION FUNCTIONS. Sperber, Daniel (Rensselaer Polytechnic Inst., Troy, N. Y.). Phys. Rev., 184: 1201-4(Aug. 20, 1969).

A method for the calculation of nucleon-capture cross sections and excitation functions is presented. The method is based on the statistical compound-nucleus model. The method is applied to the calculation of the excitation function for the reactions $^{127}I(n,\gamma)^{128}I$ and $^{209}Bi(p,\gamma)^{210}Po$. The result of the analysis indicates that the compound-nucleus mechanism is responsible for a considerably larger part of the cross section than previously believed. (auth)

1915 SIMPLE MODEL FOR CORRECTIONS TO THE ISOBARIC MULTIPLET MASS EQUATION. Henley, E. M.; Lacy, C. E. (Univ. of Washington, Seattle). Phys. Rev., 184: 1228-9(Aug. 20, 1969).

A simple nonperturbative model is used to estimate corrections to the first-order perturbation-theory formula for the isobaric multiplet masses. The leading-order correction to the equation, which is proportional to T_z^3, is found to be much smaller than expected from second-order perturbation arguments and from limits set by experiments. (auth)

1916 NUCLEAR INTERACTION MATRIX ELEMENTS IN A PHASE-SHIFT APPROXIMATION. Srivastava, M. K.; Jopko, A. M.; Sprung, D. W. L. (McMaster Univ., Hamilton, Ont.). Can. J. Phys., 47: 2459-74(Nov. 15, 1969).

A method suggested by Elliott for calculating nuclear interaction matrix elements directly from phase shifts is developed into a practical scheme applicable to all partial waves. Matrix elements are constructed from experimental phase shifts and compared to several other calculations. A shell-model calculation of ^{58}Ni based on these matrix elements gives results comparable to those of Kuo. (auth) (CANADA)

REACTOR TECHNOLOGY

Commercial Power Reactors

Refer also to abstracts 265, 272, 349, 354, 422, 423, 455, 457, 458, 467, 468, 470, 471, 960, 961, 1022, and 1066.

1917 (APDA-CFE-32) COMPILATION OF CURRENT TECHNICAL EXPERIENCE AT ENRICO FERMI ATOMIC POWER PLANT, APRIL 1969. Mueller, R. E. (Atomic Power Development Associates, Inc., Detroit, Mich.). Aug. 1969. Contract AT(11-1)-865. 47p. Dep. CFSTI.

Information on operations and maintenance experience concerning the nuclear plant and related systems is presented. Included are discussions of damage to the holddown inspection tool, the status of plant modifications, and special tests of plant components and systems. (H.D.R.)

1918 (CONF-681101-39) RECENT DEVELOPMENTS IN THE SAFETY AND SITING POLICY FOR POWER REACTORS IN THE UNITED KINGDOM, 1968. Gronow, W. S. (Ministry of Power, London (England)). 5p. Dep. CFSTI. UK.

From International Conference on the Constructive Uses of Atomic Energy, Washington, D. C.

A review of safety requirements and procedures involved in the siting of power reactors in U. K. is presented. Problems associated with siting of power reactors are described. (D.C.C.)

1919 (DOCKET-1151-4) ELK RIVER REACTOR. Monthly Operating Report No. 83, September 1969. (Rural Cooperative Power Association, Elk River, Minn.). Oct. 20, 1969. 10p. (COO-651-79). Dep. CFSTI.

1920 (DOCKET-50003-13) INDIAN POINT UNIT NO. 1. High Pressure Boron Injection System Modifications. (Consolidated Edison Co. of New York, Inc., New York). Oct. 22, 1969. 3p. Dep. CFSTI.

Revised information concerning modifications in the high pressure boron injection system is presented. (D.C.C.)

1921 (DOCKET-50010-50) DRESDEN NUCLEAR POWER STATION, [UNIT 1]. Initial Loading and Testing in the Minimum Critical Configuration. (Commonwealth Edison Co., Chicago, Ill.). Nov. 12, 1959. 5p. Dep. CFSTI.

Initial loading procedures are described. Critical testing programs and results are presented. (D.C.C.)

1922 (DOCKET-50010-51) DRESDEN NUCLEAR POWER STATION, [UNIT 1]. Testing Program for Power Operation. (Commonwealth Edison Co., Chicago, Ill.). Mar. 17, 1960. 5p. Dep. CFSTI.

Initial power testing programs and procedures for 0 to 315 MW(t) conditions are outlined. (D.C.C.)

1923 (DOCKET-50010-52) DRESDEN NUCLEAR POWER STATION, UNIT 1. Technical Specifications, Proposed Change No. 13. (Commonwealth Edison Co., Chicago, Ill.). Feb. 21, 1967. 7p. Dep. CFSTI.

Revised information is presented on design modifications of the fuel elements. (D.C.C.)

1924 (DOCKET-50010-53) DRESDEN NUCLEAR POWER STATION, [UNIT 1]. Supplementary Data on the Proposed Dresden High Void Test. (Commonwealth Edison Co., Chicago, Ill.). Sept. 22, 1961. 4p. Dep. CFSTI.

Power tests stability and burnout margins are analyzed. Data recording procedures for evaluating margins are outlined. (D.C.C.)

1925 (DOCKET-50010-54) DRESDEN NUCLEAR POWER STATION, UNIT 1. License No. DPR-2: Technical Specifications Change No. 14. (Commonwealth Edison Co., Chicago, Ill.). Apr. 22, 1968. 7p. Dep. CFSTI.

Revised technical specifications for fuel elements are presented. (D.C.C.)

1926 (DOCKET-50010-55) DRESDEN NUCLEAR POWER STATION, UNIT 1. Loss of Power to Post Incident System Valves. (Commonwealth Edison Co., Chicago, Ill.). Oct, 3, 1968. 6p. Dep. CFSTI.

Procedures are described for a power loss to the emergency system valve actuators. Modifications to the reactor building to prevent future incidents are presented. (D.C.C.)

1927 (DOCKET-50010-56) DRESDEN NUCLEAR POWER STATION, UNIT 1. Difficulty with Operation of Control Rod Drives. (Commonwealth Edison Co., Chicago, Ill.). Mar. 18, 1969. 2p. Dep. CFSTI.

DRESDEN POWER REACTOR, UNIT 1—control elements of, technical specifications for operation with stuck

1928 (DOCKET-50029-103) YANKEE NUCLEAR POWER STATION. Operation Report No. 61, January 1966. (Yankee Atomic Electric Co., Boston, Mass.). Feb. 23, 1966. 10p. Dep. CFSTI.

1929 (DOCKET-50029-104) YANKEE NUCLEAR POWER STATION. Operation Report No. 62, February 1966. (Yankee Atomic Electric Co., Boston, Mass.). Mar. 23, 1966. 11p. Dep. CFSTI.

1930 (DOCKET-50029-105) YANKEE NUCLEAR POWER STATION. Operation Report No. 63, March 1966. (Yankee Atomic Electric Co., Boston, Mass.). Apr. 28, 1966. 10p. Dep. CFSTI.

1931 (DOCKET-50029-106) YANKEE NUCLEAR POWER STATION. Operation Report No. 64, April 1966. (Yankee Atomic Electric Co., Boston, Mass.). May 23, 1966. 10p. Dep. CFSTI.

1932 (DOCKET-50029-107) YANKEE NUCLEAR POWER STATION. Operation Report No. 65, May 1966. (Yankee Atomic Electric Co., Boston, Mass.). June 24, 1966. 9p. Dep. CFSTI.

1933 (DOCKET-50146-43) SAXTON REACTOR. Coolant System Inspection Report. License No. DPR-4: Amendment 7 to Technical Specifications Change No. 32. (Saxton Nuclear Experimental Corp., Pa.). Oct. 27, 1969. 42p. Dep. CFSTI.

Inspection procedures and results for the cooling system are presented. 20 references. (D.C.C.)

1934 (DOCKET-50171-11) PEACH BOTTOM ATOMIC POWER STATION. Monthly Operations Report No. 42, August 1969. (Philadelphia Electric Co., Pa.). Oct. 14, 1969. 16p. Dep. CFSTI.

1935 (DOCKET-50237-16) DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3. [Supplementary Information], Amendment 11 for Unit 2 and Amendment 12 for Unit 3. (Commonwealth Edison Co., Chicago, Ill.). Apr. 16, 1969. 75p. (DOCKET-50249-17). Dep. CFSTI.

Seismic design analysis for the containment structures are presented. Emergency instrumentation and power systems are described. The emergency core spray cooling system is described. (D.C.C.)

1936 (DOCKET-50244-25) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT NO. 1. Provisional Operation License No. DPR-18; Technical Specifications. (Rochester Gas and Electric Corp., N. Y.). Sept. 19, 1969. 190p. Dep. CFSTI.

Safety limits for reactor systems are analyzed. Actuating settings and limiting conditions for emergency systems are described. Containment structure design parameters are listed. Surveillance requirements and testing schedules are presented. Operation procedures for the reactor are described. (D.C.C.)

1937 (DOCKET-50247-11) INDIAN POINT NUCLEAR GENERATING UNIT NO. 2. [Preliminary Safety Analysis Report], Amendment 11. (Consolidated Edison Co. of New York, Inc., New York). Oct. 24, 1969. 85p. Dep. CFSTI.

Information concerning the motor operated butterfly valves is presented. Buildings and facilities of Class 1 ratings which can be damaged by failure of Class 3 structures are analyzed. Stress analysis requirements for Class 1 structures are described. Primary coolant pump flywheel design specifications are presented. Leakage paths from the primary cooling system are analyzed. Containment structure composition is described. The effectiveness of the spray system for iodine removal is analyzed. The effects of spray solutions on containment materials are described. Emergency shutdown and protection systems are discussed. Diagrams of the emergency power system circuits are included. Qualifications of supervisory personnel are listed. (D.C.C.)

1938 (DOCKET-50255-20) PALISADES PLANT. [Preliminary Safety Analysis Report], Amendment 16. (Consumers Power Co., Jackson, Mich.). Oct. 23, 1969. 105p. Dep. CFSTI.

Design specifications for containment structures under seismic stresses are presented. Control rod actuation sequence circuit diagrams are included. Effects on pressure and temperature

transients of total control rod withdrawal are analyzed. Startup personnel qualifications are listed. (D.C.C.)

1939 (DOCKET-50261-15) H. B. ROBINSON UNIT NO. 2. Preliminary Safety Analysis Report, Amendment 10. (Carolina Power and Light Co., Raleigh, N. C.). Oct. 27, 1969. 182p. Dep. CFSTI.

Revised design parameters are presented. Radiation monitoring programs for the reactor site are described. Effectiveness of the iodine removal containment spray system is analyzed. Emergency cooling systems are described. Stress analysis for buildings under tornado wind forces is presented. Safety limits for reactor systems are described. Emergency safety procedures are described. (D.C.C.)

1940 (DOCKET-50263-27) MONTICELLO NUCLEAR GENERATING PLANT, [UNIT NO. 1]. Description of the Environmental Monitoring Program. (Northern States Power Co., Minneapolis, Minn.). Revised June 1, 1969. 23p. Dep. CFSTI.

Environmental monitoring data and procedures are presented for radiation monitoring and ecological monitoring. (D.C.C.)

1941 (DOCKET-50263-28) MONTICELLO NUCLEAR GENERATING PLANT, [UNIT NO. 1]. Environmental Monitoring Program. Annual Report, 1968. (Northern States Power Co., Minneapolis, Minn.). June 1, 1969. 207p. Dep. CFSTI.

Environmental monitoring data and procedures are presented for radiation monitoring and ecological monitoring. The radiation monitoring consists of personnel dose records and environment sampling. Ecological monitoring consists of chemical analyses of water samples. (D.C.C.)

1942 (DOCKET-50267-13) FORT ST. VRAIN NUCLEAR GENERATING STATION, [UNIT 1]. [Preliminary Safety Analysis Report], Amendment 3. (Public Service Co. of Colorado, Denver). July 1967. 882p. Dep. CFSTI.

Stress analyses for Class 1 structures are presented. The effects of tornado wind forces on reactor buildings are analyzed. Surface geology and seismic history of the site are described. Stress analysis and design parameters for the prestressed concrete pressure vessel are presented. Reactor accident kinetics are analyzed. Radiation monitoring for the site is described. Fuel cycle requirements are listed. Emergency shutdown systems are described. Penetrations are illustrated. (D.C.C.)

1943 (DOCKET-50282-14) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2. Quality Assurance Program. (Northern States Power Co., Minneapolis, Minn.). Oct. 27, 1969. 13p. (DOCKET-50306-14). Dep. CFSTI.

Quality assurance procedures for design, procurement, fabrication, construction, installation, and testing are described. (D.C.C.)

1944 (DOCKET-50282-15) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2. Additional Information on Fire Damages. (Northern States Power Co., Minneapolis, Minn.). Oct. 27, 1969. 83p. (DOCKET-50306-15). Dep. CFSTI.

Information is presented relating to the concrete compositions used in the reactor building. Testing results for the concretes are listed. Stress analyses of fire-damaged concrete specimens are presented. Stress analyses of fire-damaged reinforcing steel members are included. (D.C.C.)

1945 (DOCKET-50289-19) THREE MILE ISLAND NUCLEAR STATION, UNIT 1. ACRS Report. (Metropolitan Edison Co., Reading, Pa.). Apr. 6, 1968. 2p. Dep. CFSTI.

Information is presented relating to the safety of the power plant buildings under conditions of an aircraft crash. (D.C.C.)

1946 (DOCKET-50308-3) BOLSA ISLAND NUCLEAR POWER AND DESALTING PLANT. Withdrawal of License Application. (Southern California Edison Co., Camp Pendleton, Calif. San Diego Gas and Electric Co., Calif.). Dec. 27, 1968. 10p. Dep. CFSTI.

1947 (DOCKET-50322-14) SHOREHAM NUCLEAR POWER STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment 8. (Long Island Lighting Co., Mineola, N. Y.). Oct. 24, 1969. 128p. Dep. CFSTI.

Information concerning aircraft traffic near the reactor site is presented. Diagrams of the reactor site are included. The cooling system is described. Geologic analysis of site is presented. Effects of seismic stresses on site are analyzed. Piping systems standards are listed. Containment structures are described. (D.C.C.)

1948 (DOCKET-50327-11) SEQUOYAH NUCLEAR PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 6. (Tennessee Valley Authority, [Knoxville]). Oct. 17, 1969. 94p. (DOCKET-50328-11). Dep. CFSTI.

QUALITY CONTROL — safety analysis of, programs at Sequoyah Power Reactor Units 1 and 2
SEQUOYAH POWER REACTOR, UNIT 1 — quality assurance program for, safety analysis of
SEQUOYAH POWER REACTOR, UNIT 2 — quality assurance program for, safety analysis of (D.C.C.)

1949 (DOCKET-50331-14) DUANE ARNOLD ENERGY CENTER. Preliminary Safety Analysis Report, Amendment 8. (Iowa Electric Light and Power Co., Cedar Rapids). Oct. 24, 1969. 60p. Dep. CFSTI.

The emergency power system is described. Emergency core cooling system is discussed, and flow diagrams are included. Leak detection system is described. Surveillance procedures for the pressure vessel are outlined. Classification of piping systems is presented. The effects of earthquake stresses on reactor buildings and emergency systems are analyzed. Procedures for removing a dropped fuel storage container are reviewed. Radiation doses from damaged containers are analyzed. (D.C.C.)

1950 (DOCKET-50333-10) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Preliminary Safety Analysis Report, Amendment 7, Suppl. 6. (Power Authority of the State of New York). Oct. 27, 1969. 61p. Dep. CFSTI.

Seismic stress analysis for cooling system piping is presented. Stress analysis for pressure vessel material is discussed. Pressure vessel leak detection system is described. The emergency core cooling system is analyzed. Containment structure performance characteristics are listed. Emergency fuel handling procedures are described. (D.C.C.)

1951 (DOCKET-50336-4) MILLSTONE NUCLEAR POWER STATION, UNIT 2. Preliminary Safety Analysis Report, Amendment 1. (Connecticut Light and Power Co., Hartford. Hartford Electric Light Co., Conn. Western Massachusetts Electric Co., Greenfield. Millstone Point Co., Wethersfield, Conn.). Oct. 27, 1969. 261p. Dep. CFSTI.

Revised and additional information is provided for the containment structure isolation valve arrangements. The emergency power system is described. Piping systems classifications are listed. Radiation doses related to the design basis incident are analyzed. Geologic and hydrologic analyses of the site are included. Quality assurance programs are described. (D.C.C.)

1952 (GA-9494) 40-MW(E) PROTOTYPE HIGH-TEMPERATURE GAS-COOLED REACTOR POSTCONSTRUCTION RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period Ending July 31, 1969. (Gulf General Atomic, Inc., San Diego, Calif.). Aug. 29, 1969. Contract AT(04-3)-314. 41p. Dep. CFSTI.

FISSION PRODUCTS — distribution in Peach Bottom reactor fuel element graphite, (E)
— content in Peach Bottom reactor cooling system and core, (E/T)
PEACH BOTTOM POWER REACTOR, UNIT 1 — operation during May to July 1969
— xenon worth in, decay and buildup of, (E/T)
— reactivity variations with core burnup and power variations in, (E/T)
— fuel elements for, distribution of fission products in graphite of, (E)
— cooling system of, fission product activities in, (E/T)
— core of, equilibrium fission product activities in, (T)
REACTOR FUEL ELEMENTS — fission product distribution and release from gas cooled, (E)
— cladding of, fission product distribution in graphite, (E)
XENON ISOTOPES Xe-135 — content in Peach Bottom reactor core, decay and buildup of, (E/T) (H.D.R.)

1953 (HPR-112) HBWR QUARTERLY PROGRESS REPORT, APRIL-JUNE 1969. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). Aug. 1969. 123p. Dep. CFSTI (U. S. Sales Only).

FILTERS — testing of HBWR containment system, for iodine removal
HALDEN BOILING REACTOR — operation during April to June 1969, review of
— instrumentation for, development during April to June 1969
IODINE — removal from HWBR containment system, efficiency of filters for
PLUTONIUM OXIDES PuO_2 — PuO_2 - UO_2, fuel elements of Zircaloy 2 clad, burnup of HBWR
REACTOR CONTAINMENT SYSTEMS — filters for HBWR, testing for iodine removal efficiency of

REACTOR CONTROL SYSTEMS—development of HBWR on-line digital computer, during April to June 1969
REACTOR FUEL ELEMENTS—burnup of HBWR plutonium oxide (PuO_2)–uranium oxide (UO_2) and uranium oxide (UO_2)
—assemblies of HBWR Zircaloy 2 clad uranium oxide (UO_2) pellet and powder, description of test
—cladding of HBWR, radiation effects on Zircaloy-2
URANIUM OXIDES UO_2—fuel elements of Zircaloy 2 clad, burnup of HBWR
—PuO_2–UO_2, fuel elements of Zircaloy 2 clad, burnup of HBWR
ZIRCALOY-2—cladding of HBWR plutonium oxide (PuO_2)–uranium oxide (UO_2) and uranium oxide (UO_2) fuel elements of, radiation effects on (D.C.C.)

1954 (TID–25243) GUNDREMMINGEN NUCLEAR POWER PLANT. Monthly Report, July 1969. (Kernkraftwerk RWE-Bayernwerk G.m.b.H., Gundremmingen (West Germany)). Aug. 14, 1969. 48p. (In German). Dep. CFSTI.

Operations and maintenance requirements during July 1969 are described. Radiation doses for personnel are listed. Radiation monitoring measurements for reactor systems are included. (D.C.C.)

1955 (TID–25244) GUNDREMMINGEN NUCLEAR POWER PLANT. Monthly Report, August 1969. (Kernkraftwerk RWE-Bayernwerk G.m.b.H., Gundremmingen (West Germany)). Sept. 9, 1969. 58p. (In German). Dep. CFSTI.

Operations and maintenance requirements during August 1969 are described. Radiation doses for personnel are listed. Radiation monitoring measurements for reactor systems are included. (D.C.C.)

1956 GAS-COOLED REACTOR'S STANDOUT PERFORMANCE. Olds, F. C. Power Eng., 73: No. 10, 42-3(Oct. 1969).

A review of the operation performance of the Peach Bottom Power Reactor Unit 1 is presented. (D.C.C.)

1957 ENTRANCE BLOCK FOR THE NUCLEAR POWER STATIONS AT SAINT-LAURENT-LES-EAUX (FRANCE). Dziewolski, Richard. Acier-Stahl-Steel, No. 4, 151-6(1969).

Design features of the entrance building and observation platform are presented. Diagrams are included. (D.C.C.)

1958 FIVE-YEARS OPERATION OF NOVO-VORONEZH NUCLEAR POWER STATION. Ovchinnikov, F. Ya.; Voronin, L. M.; Golubev, L. I. At. Energ. (USSR), 27: 274-80(Oct. 1969). (In Russian).

The results of operating the water reactor and the primary circuit process equipment during 1964 to 1969 are presented. The plant main process equipment is analyzed. The reactor radiation safety is found to be normal. The experimental results for increasing the reactor power and the operation time are given. (4 references) (auth)

1959 BURN-UP DETERMINATION IN FUEL ELEMENTS OF THE NOVO-VORONEZH ATOMIC POWER PLANT FIRST REACTOR WITH USE OF A Ge(Li)-DETECTOR. Miller, O. A.; Demidov, A. M.; Ovchinnikov, F. Ya.; Golubev, L. I.; Sunchugashev, M. A. At. Energ. (USSR), 27: 281-6(Oct. 1969). (In Russian).

The amount of fission products in 15 fuel elements from the fuel assembly of the first reactor of the Novo-Voronezh atomic power plant was determined with use of a Ge(Li)-detector. The fuel assembly was irradiated during 3 years and cooled during 9 months. The determination of ^{137}Cs distribution along the fuel length did not show an appreciable migration of this isotope in the fuel composition (UO_2). The burn-up distribution ratios along the length and diameter of the fuel assembly were found to be 1.27 ± 0.07 and 1.21 ± 0.06 correspondingly. The total burn-up of ^{235}U and ^{239}Pu was determined by measured amount of ^{137}Cs and the contribution of ^{239}Pu burnup by ^{106}Ru. Experimental errors are presented. (16 references) (auth)

1960 POWER REACTORS FOR NUCLEAR POWER PLANTS. FROM THE FIRST NUCLEAR POWER PLANT IN THE WORLD TO THE 2 GW(e) NUCLEAR POWER PLANT. Petros'yants, A. M. At. Energ. (USSR), 27: 263-74(Oct. 1969). (In Russian).

The advantages of nuclear power, and nuclear power achievements in the U.S.S.R. are considered. The experience gained from the operation of the Beloyarsk, Novo-Voronezh and Melekess nuclear power plants is described. The future developments of tube and vessel type power reactors are stated, specific data concerning some new projects of power reactors are given. The characteristics of the BOR-60, BN-350 and BN-600 fast reactors are presented. 16 references. (auth)

1961 DEFECT INSPECTION OF THE JPDR PRESSURE VESSEL BY THE ULTRASONIC REFLECTOSCOPE METHOD. Futamura, Yoshiaki (Japan Atomic Energy Research Inst., Tokai). Karyoku Hatsuden, 20: 298-312(Mar. 1969). (In Japanese).

In the regular inspection of JPDR in May 1966, cracks were found on the clad part of upper cover of the pressure vessel by liquid infiltration method of defect detection. The possible existence of cracks on the hand welded parts of the nozzle and the lower end plate was suspected, therefore the plant was shutdown in May 1968, and inspection of the internal surface of the pressure vessel was carried out by boloscope, liquid infiltration, and ultrasonic reflectoscope methods. The inspected parts by the ultrasonic method were the outlet and inlet nozzles for forced circulation, the whole surface of upper cover, the welded parts of upper and lower flanges, and the sealing surfaces of flanges. Fundamental data were obtained by using specimens for comparison with artificial defects and a mock-up of the nozzle part. The objective for the inspection of defects penetrating into base metals was attained by 45° oblique and perpendicular detection methods. (NSA of Japan)

1962 POST-OPERATION INSPECTION ON JPDR PRESSURE VESSEL. Suguri, Susumu (Japan Atomic Energy Research Inst., Tokai). Genshiryoku Kogyo, 15: No. 7, 33-7 (July 1969). (In Japanese).

In the regular inspection in May 1966, of the Japan Power Demonstration Reactor (BWR), fine hair cracks were detected in the stainless-steel lining of the top plate of the pressure vessel. This lining was removed and replaced with a new lining by welding, and the JPDR operation was resumed. Suspecting existence of similar hair cracks also at nozzles and bottom of the pressure vessel body, the reactor was shutdown in May 1968, and inside of the pressure vessel was inspected by boloscope, electric resistance, ultrasonic probe and liquid penetration methods. The electric resistance method, first used in the post-operation inspection, gave good results. The existence of fine cracks and their possible positions were detected; all were in the places welded by hand, the largest depth of cracks was about 3 mm, and those cracks did not reach the base metal. Although inspections were carried out in intense radiations, no significant exposures were experienced, owing to the remote-control inspection. (NSA of Japan)

Power Reactor Development

Refer also to abstracts 257, 472, and 1063.

1963 (ANL–7606) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, AUGUST 1969. (Argonne National Lab., Ill.). Sept. 26, 1969. Contract W-31-109-eng-38. 134p. Dep. CFSTI.

Highlights of project activities are summarized for the month of August 1969. Fuel and components development programs for the LMFBR are described. LMFBR physics measurements and ZPR-3, ZPR-6, ZPR-9, and ZPPR operations during August are reviewed. Research and development programs in the EBR-2 are described. Nuclear safety studies, including TREAT operations, and chemical separation activities are discussed. (D.C.C.)

1964 (BAW–1328(Vol.3)) 1000-MWe LMFBR FOLLOW-ON STUDY. TASK II AND III FINAL REPORT. VOLUME 3. CONCEPTUAL SYSTEM DESIGN DESCRIPTIONS (SECTIONS 8–14). (Babcock and Wilcox Co., Lynchburg, Va. Power Generation Div.). Feb. 1969. Contract 31-109-38-1998. 444p. Dep. CFSTI.

For Argonne National Lab., Ill.

Individual conceptual system design descriptions (CSDDs) for the reference 1000 MW(e) LMFBR central station power plant are presented. The CSDDs included are: (1) reactor auxiliary, (2) intermediate coolant, (3) steam generator, (4) energy conversion, (5) instrumentation and control, (6) electrical, and (7) safety systems. (H.D.R.)

1965 (BAW–1328(Vol.4)) 1000-MWe LMFBR FOLLOW-ON STUDY. TASK II AND III FINAL REPORT. VOLUME 4. TRADE-OFF STUDIES. (Babcock and Wilcox Co., Lynchburg, Va. Power Generation Div.). Nov. 1968. Contract 31-109-38-1998. 328p. Dep. CFSTI.

For Argonne National Lab., Ill.

Two or more alternate concepts, or approaches to the design of specific reactor features, are compared and evaluated with a view to selecting the concept to be included in the reference design LMFBR. The seven trade-off studies included are: (1) spoiled versus unspoiled core, (2) number of primary and intermediate heat transfer loops, (3) vented versus nonvented fuel pins, (4)

steam cycle selection, (5) shipping casks, (6) on-site versus off-site reprocessing and fabrication, and (7) plant arrangement and refueling method. (H.D.R.)

1966 (BAW-1328(Vol.5)) 1000-MWe LMFBR FOLLOW-ON STUDY. TASK II AND III FINAL REPORT. VOLUME 5. PARAMETRIC STUDIES. (Babcock and Wilcox Co., Lynchburg, Va. Power Generation Div.). Jan. 1969. Contract 31-109-38-1998. 198p. Dep. CFSTI.

Parametric studies undertaken to investigate the quantitative effects of selected parameters on the design and economics of the 1000 MW(e) liquid metal fast breeder reactor (LMFBR) concepts are described. Values of the major core and reactor plant design and operating parameters that result in an LMFBR optimized for the minimum net electric generating cost are determined. Data that will permit cost-benefit evaluations with respect to the research, development, and component testing program required for the design and construction of the LMFBR are provided. The fuel and power generating costs of the reference design are determined over a range of values of selected economic parameters. The reference design fuel doubling time is determined over a range of fuel burnups and outpile times. (H.D.R.)

1967 (BAW-1331(Vol.1)) 1000-MWe LMFBR FOLLOW-ON STUDY. TASK IV FINAL REPORT. RESEARCH AND DEVELOPMENT REQUIREMENTS. (Babcock and Wilcox Co., Lynchburg, Va. Power Generation Div.). June 1969. Contract 31-109-38-1998. 406p. Dep. CFSTI.

For Argonne National Lab., Ill.

The LMFBR Program Plan for research and development requirements, as evaluated by Babcock and Wilcox, is detailed. Included are design details and cost estimates for: plant design, components, instrumentation and control, sodium technology, and core design. (M.L.S.)

1968 (BAW-1331(Vol.2)) 1000-MWe LMFBR FOLLOW-ON STUDY. TASK IV FINAL REPORT. RESEARCH AND DEVELOPMENT REQUIREMENTS. (Babcock and Wilcox Co., Lynchburg, Va. Power Generation Div.). June 1969. Contract 31-109-38-1998. 401p. Dep. CFSTI.

For Argonne National Lab., Ill.

The LMFBR Program Plan for research and development requirements, as evaluated by Babcock and Wilcox, is given. Fuel and cladding materials development is detailed; fuel element design and fabrication is discussed. Details of design and costs for development of primary and secondary sodium system structures and components are given. Fuel recycle details are discussed. The efforts required for development of analytical physics methods are evaluated; development costs are estimated. (M.L.S.)

1969 (ORNL-TM-2407) VISCOELASTIC ANALYSIS OF GRAPHITE UNDER NEUTRON IRRADIATION AND TEMPERATURE DISTRIBUTION. Chang, Shih-Jung; Pugh, C. E.; Moore, S. E. (Oak Ridge National Lab., Tenn.). Oct. 1969. Contract W-7405-eng-26. 33p. Dep. CFSTI.

The adaptation and application of linear viscoelasticity to the stress analysis of irradiated graphite under temperature gradients and dimensional changes are examined. Under the assumptions of uniform neutron distribution throughout the body and of a temperature-independent creep function, the generalized plane-strain viscoelastic solution for an arbitrary two-dimensional cross section is represented by the sum of four associated elastic solutions when multiplied by appropriate functions of the neutron dose. From this plane-strain formulation, solutions are obtained for various thick-walled circular cylinders which represent graphite core components in a Molten-Salt Breeder Reactor (MSBR) design study. These cylinders are subjected to radial temperature distributions and to a temperature-dependent neutron-induced dimensional change which has a quadratic dependence upon the accumulated neutron exposure. The creep function used is based upon available experimental test results. The stress and strain components are determined as functions of the accumulated dose. An analytical expression is developed for the rate of change of the axial stress for large values of accumulated neutron dose where this stress component has a linear dependence on the dose. Design lifetimes for the graphite core components are developed in accordance with both a volumetric distortion and an axial strain criterion. The methods presented can be extended to the three-dimensional axisymmetrical case. (auth)

1970 (WARD-2000-96) COST OPTIMIZATION AND PARAMETRIC STUDIES. WESTINGHOUSE 1000-MWe LMFBR. Redding, A. H.; Dyos, M.; Mangus, J. D. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). [nd]. Contract 31-109-38-2000. 164p. Dep. CFSTI.

For Argonne National Lab., Ill.

Results of the FABROC and SFBRODT computer programs for optimum economic parameters of the conceptual 1000 MW(e) LMFBR are presented. Optimization calculations include: fuel cycle, coolant loops, power conversion systems, and piping systems. (3 references) (D.C.C.)

1971 POWER PLANT CIRCUIT ARRANGEMENTS FOR STEAM COOLED FAST BREEDER REACTORS. Seeliger, Dieter; Grundmann, Manfred; Amon, Franz. At. Strom, 15: 120-7(July-Aug. 1969). (In German).

Because of the cancellation of the steam cooled fast breeder reactor project, published power plant proposals are collected. The power plant specified by AEG is described, and the progress on the 300 MW prototype is discussed. 22 references. (tr-auth)

1972 COMPETITIVE VIGOR IN NUCLEAR POWER. Ramey, James T. Harvard Business Rev., 46: 126-42(July-Aug. 1968).

The U. S. civilian power reactor industry is described and its potential for growth is examined. Highlights of the AEC Plowshare Program and radioisotope development projects are discussed. (H.D.R.)

1973 STATUS OF ATOMIC ENERGY DEVELOPMENT AND UTILIZATION. Kagaku Gijutsucho Geppo, No. 154, 16-18(June 1969). (In Japanese).

The state of atomic-energy development and utilization, as of the end of March 1968, is surveyed. For investments and production the period from April 1967 to March 1968 is reviewed. (NSA of Japan)

1974 PROGRAM FOR ATOMIC ENERGY DEVELOPMENT AND UTILIZATION IN FISCAL 1969. Kagaku Gijutsucho Geppo, No. 154, 4-7(June 1969). (In Japanese).

Outstanding features in the atomic-energy development and utilization in Japan include: start of the construction of the Experimental Fast Breeder Reactor, promotion of the studies on nuclear fusion, launching of the first nuclear-powered ship, and increased construction of atomic power stations. The program for the fiscal year 1969 (April 1969 to March 1970) is given, including the following: development of the domestic power reactors and of the conventional reactors; research and development of the nuclear fuels; research and development of nuclear-powered ships; radiation chemistry etc.; nuclear fusion; radioactivity protections; atomic power generation; production of nuclear fuels and the reprocessing; international cooperation; budgets and personnel. (NSA of Japan)

Kinetics and Dynamics

Refer also to abstract 1775.

1975 (AI-AEC-12843) EFFECT ON FAST BREEDER REACTOR CALCULATIONS OF USING REGION-DEPENDENT MULTIGROUP CROSS-SECTIONS. Fillmore, F. L. (Atomics International, Canoga Park, Calif.). Sept. 15, 1969. Contract AT(04-3)-701. 43p. Dep. CFSTI.

The generation of multigroup cross sections involves the use of a weighting spectrum in the formation of the average cross section in each energy group. An ultrafine group fundamental mode spectrum for the core composition is often used as the weighting spectrum. The use of a different weighting spectrum for each region of the reactor in generating group cross sections is investigated. A procedure is described for obtaining a more appropriate ultrafine group weighting spectrum for each region than the fundamental mode spectrum. The code development is described which enables the entire calculation for an assembly to be run as a four-step job in the IBM/360-50 system. Calculations were made for three fast critical assemblies and for a model of a 500-MW(e) fast breeder reactor. For some cases the use of region-dependent weighting spectra produced a significant effect on the median flux energy in a region, but in none of the calculations did these changes result in significant effects on other calculated reactor parameters. Use of region-dependent weighting spectra in the generation of 5-group libraries for one of the assemblies made no improvement in the accuracy of the 5-group results, which were significantly different from 25-group results. It is concluded that the region-dependent weighting spectra method does not result in a significant improvement in reactor neutronic calculations. 6 references. (auth)

1976 (CEA-R-3497) STUDY OF THE THERMAL AND HYDRAULIC PHENOMENA OCCURING DURING POWER EXCURSION ON A HEATED TEST SECTION. Nyer, Marcel (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1969. 153p. (In French). Dep. CFSTI (U. S. Sale Only).

Thesis. Submitted to Univ., Grenoble, France.

The thermal and hydrodynamic phenomena occurring during a power excursion were studied in an out-of-pile loop with a water cooled channel at low pressure (1 to 4 atm. abs.) Circular and rectangular test sections with electrically heated walls of two different thermal diffusivity materials (aluminum and stainless steel) were used. The rectangular test sections were 600 mm long, 35 mm wide and had a 2.9 mm gap; they simulate two half plates of the M.T.R. fuel element. Natural or forced convection are possible in the test section; the water height above it can be varied from 2.8 to 8 meters and the maximum allowed pressure at its outlet is 4 atms. abs. The influence of the initial water temperature, flow rate, pressure, water height on the water ejections, pressure variations and void fraction in the test section were studied. An interpretation of the observed phenomena and a simplified theoretical model are presented. (57 references) (auth)

1977 (LA–4190) TEMPERATURE DEPENDENCE OF THERMAL NEUTRON LEAKAGE IN UHTREX. Vigil, John C. (Los Alamos Scientific Lab., N. Mex.). May 15, 1969. Contract W-7405-eng-36. 3p. Dep. CFSTI.

Calculations show that if the room temperature calibration of the ^{10}B ion chambers is used for design conditions, the power readings will be high by a factor of 2.8. This is due to changes in the thermal neutron absorption in the reactor vessel. (3 references) (auth)

1978 (WARD–2000–93) COMPARISONS OF THE WESTINGHOUSE 1000-MWe LMFBR REFERENCE DESIGN CALCULATIONS USING THE WESTINGHOUSE 6602-M DATA AND THE MC^2 CODE WITH NEUTRON CROSS-SECTION DATA FROM THE ENDF/B FILE. Seibert, C. G.; Paik, N. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). [1968]. Contract 31-109-38-2000. 30p. Dep. CFSTI.

For Argonne National Lab., Ill.

Calculations were performed by Pitterle, Page, and Yamamoto that compare criticality values calculated with the ENDF/B data and experimental values obtained from ZPR III, Assembly 48. The results of their study show that the ENDF/B data predict an effective multiplication factor that is approximately 1.5% too low. Since the Assembly 48 isotopic composition is similar to the composition of the Task III Reference Design, it is concluded that the 6602-M library would be over-reactive in the criticality calculation by approximately 5.5%. (31 references) (auth)

1979 USE OF NON-METALLIC FLUIDS TO SIMULATE SODIUM EXPULSION. Singer, Ralph M. (Argonne National Lab., Ill.). Nucl. Eng. Design, 10: 72-8(May 1969).

The conditions that must be met in order for a non-metallic fluid to be used to simulate the dynamics of transient vaporization of a liquid metal in a channel (expulsion) are discussed. Three criteria for simulation are developed; they consist of a modeling of the hydrodynamics, power density, and vapor growth rate. These criteria are formulated in terms of dimensionless groups and sample calculations are performed for various fluids. The calculations clearly demonstrate that many non-metallic fluids can be used to simulate Na expulsion, and the final choice of a particular fluid is determined by the most convenient ranges of pressure, temperature, and heat flux required for simulation. 13 references. (auth)

1980 DESIGN STUDY OF STEAM COOLED FAST BREEDER REACTOR. Takahashi, Ryoichi; Hara, Hideki (Tokyo Inst. of Tech.). Tokyo Kogyo Daigaku Gakuho, No. 90, 27-38(Mar. 1969).

The fast steam-cooled reactor (FSCR) is described. Nuclear characteristics, depressurized and flooding reactivity, thermal characteristics, and transient responses are reviewed. Design advantages and disadvantages are noted. (NSA of Japan)

Control Systems

Refer also to abstract 358.

1981 EXPERIMENT ON SAFETY-ROD DRIVE MECHANISM FOR FAST BREEDER REACTOR. Yukishima, Itsuo (Fuji Electric Co., Kawasaki, Japan). Fuji Jiho, 42: 439-43(May 1969). (In Japanese).

As part of the second conceptual design for the Na-cooled Experimental Fast Breeder Reactor, a safety rod and its drive mechanism were constructed for testing. The proper performance of the mechanism was confirmed by tests in water. Some features of the drive mechanism are: stroke, 700 mm; driving speeds, 40 and 160 mm/min; scramming time in Na, 500 msec; and position indication, over 700 mm, with accuracy ±0.8 mm. The safety rod and the guide tube, the drive mechanism, the scramming characteristics, and the results of test, including inspection of individual members of the mechanism, the accuracy in position indication, and the up-and-down driving, are described. (NSA of Japan)

Shielding

1982 TRANSPORT OF THE NUCLEAR RADIATION IN SHIELD IRREGULARITY. Broder, D. L.; Mashkovich, V. P.; Mironov, V. N.; Popkov, K. K.; Tsypin, S. G. At. Energ. (USSR), 27: 313-23(Oct. 1969). (In Russian).

Methods of calculating radiation transport in ducts and slots of the nuclear reactor shielding are analyzed. The calculation results are compared with the experimental data. The experimental facilities for investigating neutron and gamma transport in ducts and slots are described. 54 references. (auth)

Cooling Systems

Refer also to abstracts 372–374 and 1054.

1983 (BNWL–1069) SEALING MECHANISMS FOR FFTF CLOSED LOOP AND OPEN TEST POSITION CLOSURES. Kolowith, R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 1969. Contract AT(45-1)-1830. 85p. Dep. CFSTI.

A state-of-technology survey of existing static mechanical sealing mechanisms has been conducted to determine applicability to the Fast Flux Test Facility (FFTF) closed loops and open test position top face piping. Particular attention has been directed to the 1200°F liquid Na environment, the remote make-and-break requirement, and the extremely compact space envelope typical of the closed loop reactor nozzle closure application. In the Fast Test Reactor (FTR) there are a variety of locations which must have seals capable of withstanding different but severe environmental conditions. Because of the high temperature Na and radiation environments, only metal-to-metal seals were surveyed. The survey was also limited to devices that have had some association with liquid metal, high temperature gas, or remotely operable environments. Brief descriptions of most of the mechanical sealing concepts that have been used and/or tested in some or all of the more critical environments common to FFTF are presented. A list of candidate mechanical static sealing mechanisms has been recommended for a prototypical development program. (14 references) (auth)

1984 (IN–1186(Suppl.1)) ATR PRIMARY COOLANT SYSTEM CHECK VALVE PROBLEM ANALYSIS AND CORRECTION. Burr, T. K. (Idaho Nuclear Corp., Idaho Falls). Oct. 1969. Contract AT(10-1)-1230. 56p. Dep. CFSTI.

A continuing surveillance program for the purpose of detecting a change in the primary coolant system check valve performance is described. An alternate bearing design is presented which could replace the existing bearings should the findings of the surveillance program indicate a change is necessary. (2 references) (auth)

1985 A TEMPERATURE CHART AND FORMULAS USEFUL WITH THE USASI B31.7 CODE FOR THERMAL STRESS IN NUCLEAR POWER PIPING. Brock, John E. (Naval Postgraduate School, Monterey, Calif.). Nucl. Eng. Design, 10: 79-82(May 1969).

A chart and formulas give values of $\Delta T_{1,max}$, ΔT_2, and N_{Fo} as functions of N_{Bi} for the case of sudden change in temperature of fluid flowing in a thin wall insulated pipe. These results are useful in designing according to the USAS B31.7 Code for Nuclear Power Piping. The procedure outlined is suitable at high values of heat transfer coefficient, as obtained with liquid metal-cooled and pressurized water reactors. 2 references. (auth)

1986 HEAT TRANSFER TO LIQUID METALS FLOWING IN-LINE THROUGH UNBAFFLED ROD BUNDLES: A REVIEW. Dwyer, O. E. (Brookhaven National Lab., Upton, N. Y.). Nucl. Eng. Design, 10: 3-20(May 1969).

Heat transfer to liquid metals flowing longitudinally through unbaffled rod bundles under conditions of equilateral triangular rod spacing, uniform (or approaching uniform) wall heat flux, and fully developed velocity and temperature profiles is reviewed. Theoretical predictions and experimental results are compared for both close and wide spacings. Recent results and current thinking on the following topics are also presented: circumferential variation of rod temperature, effect of rod displacement on its average heat transfer coefficient and on those of its six neighbors, effect of pitch: diameter ratio on the rod-average heat transfer coefficient, and the interrelated problems of wetting, oxides, and gas entrainment. 28 references. (auth)

1987 ANALYSIS OF LIQUID METAL HEAT TRANSFER IN ASSEMBLIES OF CLOSELY SPACED FUEL RODS. Nijsing, R.; Eifler, W. (EURATOM, Ispra, Italy). Nucl. Eng. Design, 10: 21-54(May 1969).

An analysis is presented of heat transfer in infinite triangular

or rectangular arrays of fuel rods cooled by a liquid metal in turbulent axial flow. It involves the simultaneous solution of the heat conduction equations for fuel, bond, cladding, and coolant. Fully developed flow and heat transfer conditions are considered. For close rod spacings and Peclet numbers greater than 300 the analysis is expected to yield somewhat pessimistic results due to the assumption that in the coolant turbulent heat transport is negligible with respect to heat conduction. Illustrative results have been presented for dimensionless rod spacings in the range p = 1 – 1.15 and various rod material combinations of practical interest. Theoretical predictions agree well with available experimental data at p = 1. 17 references. (auth)

1988 SAFETY ASPECTS OF PIPING DESIGN FOR ATOMIC POWER STATIONS. Nakayama, Shuichi (Tokyo Shibaura Electric Co., Kawasaki, Japan). Haikan Gijutsu, 11: No. 7, 87-95 (July 1969). (In Japanese).

Safety aspects for piping in atomic power stations are described on the following: design of the atomic-power station piping, and its classification; design fundamentals in "Nuclear Power Piping (USAS B31.7)," including classification of stresses and allowable stresses, and fatigue analysis; earthquake proof design; stress calculation; and quality control for materials. (NSA of Japan)

1989 HYDRODYNAMIC INSTABILITY IN A FULL-SCALE SIMULATED REACTOR CHANNEL. Collins, D. B.; Gacesa, M. (Canadian Westinghouse Co. Ltd., Hamilton, Ont.). pp 117-28 of Fluid Mechanics and Measurements in Two-Phase Flow Systems. London, Institution of Mechanical Engineers, 1969.

From Symposium on Fluid Mechanics and Measurements in Two-Phase Flow Systems, Leeds, England. See CONF-690922.

Experimental results are described for parallel-channel instability in boiling reactors. The experimental facilities consisted of a full-scale simulated reactor channel with two electrically heated 19-rod bundles operating in vertical high-pressure boiling water upflow, in parallel with an unheated by-pass. Data are presented showing the effect on channel flow stability of bundle power, inlet subcooling, operating pressure, by-pass ratio, and inlet and outlet feeder pressure drop coefficients. (auth) (UK)

1990 BOILING WATER REACTOR WITH INTERNAL AXIAL PUMPS. Traube, K. (AEG-Telefunken, Frankfurt am Main). Kerntechnik, 11: 531-41(Sept.-Oct, 1969). (In German and English).

The internal axial pump is a logical further development step which not only increases the availability and safety of boiling water reactors but also reduces the capital cost and the internal power requirements of a nuclear power plant. A brief review of the design, construction, and testing of the internal axial pump, as well as an overall comparison of circulation systems with internal axial pumps and with the combination of jet pumps and external pumps, is presented. (auth)

1991 DESIGN OF THE INTERNAL AXIAL PUMP. Honold, E. (Klein, Schanzlin, and Becker, Frankenthal, Ger.). Kerntechnik, 11: 541-6(Sept.-Oct, 1969). (In German and English).

The internal axial pump is a combination of reliable construction components which have already been proven in service in other pumps either singly or in combination. The specific development problem consisted of establishing the vibration behavior of the trebly coupled system consisting of the housing pipe, the bearings carrier pipe, and the casing. Satisfactory agreement was obtained between calculated and measured values. (auth)

1992 HYDRAULIC PERFORMANCE OF THE INTERNAL AXIAL PUMP IN SERVICE, TRANSIENTS, AND MALFUNCTIONS. Voigt, O. (AEG-Telefunken, Frankfurt am Main). Kerntechnik, 11: 547-55(Sept.-Oct. 1969). (In German and English).

It is shown that a plant with internal axial pumps, compared to plants with jet pumps, presents considerable advantages with respect to internal power consumption for coolant circulation and with respect to the permissible reactor power output in the event of pump outage. Transient phenomena in the improbable event of pump outage are covered by adequate safety margins and cannot endanger the core. Internal axial pumps can be excellently integrated into a nuclear steam generation system as part of the coolant circulation system. (auth)

1993 SPECIAL CONSIDERATIONS ON THE ARRANGEMENT AND MAINTENANCE OF THE INTERNAL AXIAL PUMP. Ullrich, W. (AEG-Telefunken, Frankfurt am Main). Kerntechnik, 11: 555-63(Sept.-Oct, 1969). (In German and English).

The use of internal axial pumps in the pressure vessel of a boiling water reactor entails certain modifications of the pressure vessel. A new shape has been developed for the bottom of the vessel. The pumps will be built-in in such a manner that they are not skewed out of alignment by deformations due to pressurization of the vessel and to differential thermal expansion. The flow configuration in the pressure vessel created by internal pumps with diffusors is particularly advantageous. There is no danger of vibration for any internal fixtures in the vessel. With internal coolant circulation, the external parts of the pumps can be made accessible during full load operation. The auxiliary systems and the service times of the most important functional components of the pump are designed for maximum operating reliability. (auth)

1994 TESTING OF THE AXIAL PUMP TO DATE. Huetti, A. (AEG-Telefunken, Frankfurt am Main). Kerntechnik, 11: 564-72(Sept.-Oct. 1969). (In German and English).

The aerial pump was commissioned and tested for 1000 hours in an improvised testing stand on the manufacturer's testing grounds. A further test run was started in January 1969 at Grosswelzheim. The test results fulfilled all expectations and showed that the pump may be fabricated in series without major modifications. One of the reasons for this success was that only proven pump components were used in the prototype pump. A diffusor development carried out at the same time also gave satisfactory results. (auth)

1995 CIRCULATION BLOWERS FOR GAS-COOLED REACTORS. Simon, M. (Brown, Boveri, and Cie. AG, Mannheim, Ger.). Kerntechnik, 11: 573-6(Sept.-Oct. 1969). (In German and English).

Circulation blowers in the MW range for carbon dioxide for an AGR and for helium for a THTR are described. Differences between the two designs are brought out and the simplicity and compactness of both designs are emphasized. A prototype blower with gas bearings for the THTR is now undergoing tests. (auth)

Fuels

Refer also to abstracts 425, 1022, 1072, 1080, and 1952.

1996 (ANL-7575, pp 177-80) DETERMINATION OF BURNUP OF FAST REACTOR FUELS. Larsen, R. P.; Meyer, R. J.; Crouthamel, C. E. (Argonne National Lab., Ill.).

The performances of Mo, Tc, and ^{144}Ce as burnup monitors for UO_2 fuel pins are compared. The methods of photometric titration of total rare earths and x-ray spectrometric determinations of rare earth fission products for determining the burnup of fast reactor fuels are described. (D.C.C.)

1997 (CEA-CONF-1340) FUEL HANDLING MECHANISMS IN RAPSODIE AND PHENIX. Benoist, E.; Michot, G.; Reynes, L.; Thevenot, L. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). [nd]. 10p. (CONF-690305-6). Dep. CFSTI (U. S. Sales Only).

From Remote Handling and Examination in the Fast Reactor Field Meeting, Idaho Falls, Idaho.

The fuel handling mechanisms of RAPSODIE are described. Their principal characteristics are presented, including modifications during the course of two years of operation. The fuel handling principles of the PHENIX reactor that differ are also discussed. (auth)

1998 (EUR-4238) PROGRAM FOR PLUTONIUM UTILIZATION IN THERMAL REACTORS. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). Nov. 25, 1968. 73p. Dep. CFSTI (U. S. Sales Only).

Computer programs for criticality measurements of Pu lattices are reviewed. The programs reviewed include: FLARE, TURBO, RIBOT, BURNY, and GAM–THEMOS–SQUID. Optimum core configuration of a 3 × 3 lattice is analyzed. Fuel element handling procedures are described. Isotopic compositions of irradiated uranium fuel rods are measured. Plutonium fuel cycles are analyzed. (D.C.C.)

1999 (ORNL-TM-2716) ANALYSIS OF THE VALIDITY OF FAST REACTOR FUEL TESTS IN EXISTING TEST REACTORS. Olsen, A. R.; Fitts, R. B.; Cox, C. M. (Oak Ridge National Lab., Tenn.). Oct. 1969. Contract W-7405-eng-26. 25p. (CONF-690910-6). Dep. CFSTI.

From Symposium on Developments in Irradiation Testing Technolo Sandusky, Ohio.

The neutronic and thermal environments are compared for a stainless steel-clad $(U,Pu)O_2$ fuel rod operating in a typical proposed commercial fast reactor with test conditions currently available in both thermal and fast flux test reactors. Calculations were performed to describe the cladding fluence, fuel radial power distribution, fuel and cladding temperature distributions, fuel restructuring, and fission product yields as functions of fuel burnup. The calculations indicate that properly designed and interpreted thermal flux experiments can simulate the reference fuel operating conditions in terms of temperature distributions

and average fission product yields. The cladding fast neutron fluences are very low, and the fuel radial power distribution is atypical except at high burnup. The EBR-II fast flux test simulation is, in general, quite good except for difficulties arising from the relatively low flux in the reactor which leads to the use of fully enriched uranium to obtain the 16 kW/ft peak heat rate desired. The consequences of this high enrichment are an appreciable change in certain of the fission product yields which may affect the oxygen activity in the fuel and a decrease by about a factor of 3 for the cladding fluence to fuel burnup ratio. However, the higher knock-on displacement cross section arising from the harder ERB-II spectrum tends to increase the damage per unit of fluence. (auth)

2000 (WAPD-TM-847) ROBOT: A COMPUTER PROGRAM TO SOLVE THE BOWING PROBLEM IN ROD-TYPE FUEL ELEMENTS (LWBR DEVELOPMENT PROGRAM). Urbaniak, J. J. (Bettis Atomic Power Lab., Pittsburgh, Pa.). July 1969. Contract AT(11-1)-Gen-14. 76p. Dep. CFSTI.

Described is a computer program which includes the following known mechanisms affecting fuel rod bowing: initial rod curvature, externally-applied forces and moments, internally-generated thrusts, thermal expansion, thermal gradient curvature, fuel-clad interaction, and support slippage. The history of deflections of a fuel rod under reactor operating conditions is predicted. (auth)

2001 (WASH-1097) USE OF THORIUM IN NUCLEAR POWER REACTORS. (Division of Reactor Development and Technology (AEC), Washington, D. C.). June 1969. 144p. Dep. GPO $1.25.

A review of the potential use of Th in power reactors is presented. Different reactor types are analyzed for Th fuel cycles. Characteristics of Th fuel cycles are described. Cost factors and long-range fuel demands and requirements are analyzed for power reactors. Design parameters for a conceptual 2000 MW(e) Molten Salt Breeder Reactor are presented. (65 references) (D.C.C.)

2002 STATIC AEROELASTICITY OF DISTANCING GRIDS FOR NUCLEAR REACTOR FUEL ELEMENT ASSEMBLIES. PART II. EXPERIMENTS. Kuzelka, Vaclav (National Research Inst. of Machines, Bechovice, Czech.). Jad. Energ., 15: 290-4(1969). (In Czech).

Results of the experimental determination of the static aeroelasticity in a grid model are presented. The stress-measurements have been made in a pressurized gas-flow by means of the resistance strain gauge techniques. The experimental results of aerodynamic characteristics and influence coefficients in the model are given. The experimental values are discussed and the correlation with theory is carried out. The agreement between the theory and experimental results is reasonably good. 7 references. (auth)

Operation and Economics

2003 REACTOR POWER SCALE AND POWER COST. Takeda, Eiichi (Tokyo Inst. of Tech.). Tokyo Kogyo Daigaku Gakuho, No. 90, 117-37(Mar. 1969).

Power scale dependence of capital cost, fuel cost, and operation and maintenance cost, and the resulting power cost for BWR, 1.4% enriched uranium BLW, and natural uranium PHW reactor types are analyzed. Capital yearly rates are assumed at 6%, 10%, and 14%, including interest, amortization and taxes; insurance and make-up are included in the operation and maintenance cost. Results for optimized power reactor types are presented. (NSA of Japan)

Safety and Siting

Refer also to abstract 689.

2004 (ANL-7575, pp 130-5) REACTOR SAFETY. Ivins, R. O.; Tevebaugh, A. D.; Bingle, J. D. (Argonne National Lab., Ill.).

Coolant loss accidents in water cooled power reactors are analyzed by the CHEMLOC-2 computer program. Coolant loss conditions in Zircaloy-clad UO_2 pellet-type fuels rods are measured. Failure patterns for Zircaloy 2-clad UO_2 fuel elements are measured for coolant loss conditions and in emergency core-cooling operation. Pressure generation is studied for small hot spheres moving in water, for hot spheres and molten metals falling through a water column, and for steam explosions. Experimental and theoretical values for the burning rate and burning temperature of spherical Na in an oxygen-nitrogen atmosphere are compared. (D.C.C.)

2005 (BNWL-1145) MAYPACK BEHAVIOR IN THE CONTAINMENT SYSTEMS EXPERIMENT: A PENETRATING ANALYSIS. McCormack, J. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 1969. Contract AT(45-1)-1830. 44p. Dep. CFSTI.

The Containment Systems Experiment sampling system is discussed briefly. This system uses Maypacks to sample the simulated fission products which are airborne during tests to study loss-of-coolant type of reactor accidents. The Maypack consists of a particle filter, silver screens, charcoal paper, and a charcoal bed, in order of flow. The characteristics of the Maypacks to retain and differentiate between the various forms of iodine and particulate materials are reported in detail. It is concluded that Maypacks can form the basis of a satisfactory sampling system, that the total airborne material is well retained in a properly used Maypack, that useful discrimination of iodine forms can be obtained, but that corrections are necessary at low inlet iodine concentrations, and that some ionic forms are not uniquely identified. (auth)

2006 (KFK-961) DOPPLER FEEDBACK WITH DELAYED BRAKE TIME FOR SUPER-PROMPT CRITICAL EXCURSIONS IN FAST-BREEDER REACTORS. Koehler, W. H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Apr. 1969. 16p. (In German). Dep. CFSTI (U. S. Sales Only).

The equations which describe the time-dependent processes which occur during superprompt-critical reactivity transients are derived for the point-kinetics and multigroup fast reactor models. An expression for the time-dependent feedback ($\tau = \Sigma_i DC^i \tau^i$ – Bremzeitverzoegerung) is defined. Results of a numerical evaluation of 2 dollars are tabulated; these are compared with the results from the exact solution. Criteria for evaluating the safety of a fast reactor in terms of delay in feedback processes are proposed. (M.L.S.)

2007 (ORNL-NSIC-63) COMPILATION OF NATIONAL AND INTERNATIONAL NUCLEAR STANDARDS (EXCLUDING U. S. ACTIVITIES), 5th EDITION, 1969. Cottrell, Wm. B. (United States of America Standards Inst., New York. Oak Ridge National Lab., Tenn.). Sept. 1969. Contract W-7405-eng-26. 97p. Dep. CFSTI.

All known national and international nuclear standards activities are tabulated. Standards activities of all national organizations, technical societies and government agencies are listed alphabetically by country. Standards activities are included for: Australia, Austria, Belgium, Canada, Denmark, France, Germany, Hungary, India, Israel, Italy, Japan, Netherlands, Norway, Pakistan, Republic of South Africa, Sweden, United Kingdom, and Yugoslavia. International organizations activities include: Bureau Venitas, European Organization for Nuclear Research, European Atomic Energy Community, International Air Transport Association, IAEA, International Commission on Radiological Protection, International Commission on Radiation Units and Measurements, International Electrotechnical Commission, Intergovernmental Maritime Consultative Organization, International Organization for Standardization, Floyds, Organization for Economic Cooperation and Development, European Nuclear Energy Agency, and United Nations. 17 references. (D.C.C.)

2008 (ORNL-tr-2240) STUDY ON REMOVAL OF IODINE FROM ATMOSPHERE BY SPRAY. III. REMOVAL OF ORGANIC IODIDES BY SPRAY. Nishizawa, Yukinori; Oshima, Shigeo; Maekawa, Tatsuo. Translated by Hisashi Kubota (Oak Ridge National Lab., Tenn.), from Nippon Genshiryoku Gakkaishi, 11: 262-7(1969). 10p. Dep. CFSTI.

The effectiveness of removal spray for organic iodine compounds is measured for 25° to 150°C. The organic iodine compounds tested include: CH_3I; C_2H_5I; and C_6H_6I. The runs from 25°C to 80°C were conducted at atmospheric pressure under steady state spray process keeping the spray water and container temperature constant. The runs between 100°C and 150°C used the cooling process in which cold spray water was introduced into an atmosphere of saturated steam to simulate accident conditions. 6 references. (auth)

2009 (ORNL-tr-2241) STUDY ON REMOVAL OF IODINE FROM ATMOSPHERE BY SPRAY. IV. REMOVAL OF IODINE BY REACTIVE SPRAYS. Nishizawa, Yukinori; Oshima, Shigeo; Maekawa, Tatsuo. Translated by Hisashi Kubota (Oak Ridge National Lab., Tenn., from Nippon Genshiryoku Gakkaishi, 11: 340-6(1969). 15p. Dep. CFSTI.

The results of measurements are analyzed for spray washout rates under varying solution temperature and concentration conditions when a solution which reacts with iodine is used as the spray. Materials tested as sprays include: NaOH; $Na_2S_2O_3$; and Na_2SO_3 solutions. Test temperatures ranged from room tempera-

ture to 150°C. The spray runs between room temperature and 80°C were carried out by the steady state spray process in which both the spray water and container temperatures were held constant. The runs at 100 to 150°C were designed to simulate actual incident conditions by following the cooling spray method in which cold spray is injected into a saturated steam atmosphere. Eight references. (auth)

2010 (WARD-2000-84) 1000-MWe LMFBR FOLLOW-ON STUDY. TASK V. SAFETY STUDIES. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Dec. 1968. Contract 31-109-38-2000. 131p. Dep. CFSTI.

For Argonne National Lab., Ill.

Safety studies for design requirements of a 1000 MW(e) LMFBR are reviewed. Safety studies include the following topics: overall plant requirements; core protection and containment; nuclear and radiation controls; reliability and testability of protection systems; reactivity control; reactor coolant boundary; engineered safety features; and fuel and waste storage systems. (D.C.C.)

Research and Test Reactors

Refer also to abstracts 455, 464, 469, 473, 477, 494, 947, 1963, 1973–1975, 1983, 1997, and 2067.

2011 (AAEC/M-16) REACTOR HIFAR: THE MAIN LIGHT WATER PUMP CIRCUITS (S6). Miller, W. A. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). July 1969. 11p. Dep. CFSTI (U. S. Sales Only).

Includes Drawings.

The operation procedures of the relay circuits associated with the control of the main light water pumps of the reactor HIFAR are described. (auth) (Australia)

2012 (AECL-3364) CALCULATED THERMAL NEUTRON FLUX SPECTRA INSIDE A WATER ANNULUS. Kushneriuk, S. A.; Nicholls, J. P. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). May 1969. 68p. Dep. CFSTI (U. S. Sales Only). CAN $1.50.

Samples of mixed uranium and plutonium isotopes were irradiated in a special facility in the NRU reactor. The facility consisted of two vertical tubes, an outer and an eccentrically located inner tube, with the space between the tubes filled with light water. The experimental arrangement and procedures are described. Calculations and considerations used in assessing the neutron flux spectra which existed in the samples are summarized. The significance of the calculated spectra to the calculation of the ^{235}U and ^{239}Pu effective neutron cross section are discussed. The neutron flux spectrum in an irradiation position in the graphite reflector of the Dido reactor is examined briefly. (H.D.R.)

2013 (CEA-CONF-1317) AUTOMATION OF EXPERIMENTAL COMPLEX DEVICES IN A NUCLEAR REACTOR. Guerin, M.; Grevaz, M. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Apr. 25, 1969. 16p. (In French). (CONF-690626-1). Dep. CFSTI (U. S. Sales Only).

From Meeting on Automation in Nuclear Research and Industry, Grenoble, France.

A complex computer-based system for data acquisition and processing which was installed in the SILOE reactor is described. The system monitors the experiments, in-core radiation doses, evaluates safety system parameters, and continuously evaluates reactor operating data. The general organization and functioning of the programs for data acquisition and processing are summarized. (M.L.S.)

2014 (DOCKET-50128-1) TEXAS A AND M RESEARCH REACTOR. Startup Test Program. Technical Report No. 1. (Texas Engineering Experiment Station, College Station). Sept. 1963. 31p. Dep. CFSTI.

Thermal neutron flux distributions were measured for core loading number two by the foil activation method. Equations used for the calculation of the power in watts produced in the core are presented. Reactivity worth data obtained in the calibration of the control rods are reported. (H.D.R.)

2015 (DOCKET-50128-2) TEXAS A AND M RESEARCH REACTOR. Analysis of Recorded Data from Particulate Air Monitor, September 1961–January 1963. Technical Report No. 2. (Texas Engineering Experiment Station, College Station). Sept. 1963. 7p. Dep. CFSTI.

Analysis of the continuous air monitoring data indicates an average background activity of 200 cpm. The history of occurrences above normal background is presented. (H.D.R.)

2016 (DOCKET-50128-3) TEXAS A AND M RESEARCH REACTOR. Testing the Degree of Mixing in the Liquid Waste Hold-Up Tank. Technical Report No. 3. (Texas Engineering Experiment Station, College Station). Sept. 1963. 5p. Dep. CFSTI.

Measurements of the mixing in the liquid waste hold-up tanks by nephelometric and fluorometric methods indicate that: (1) adequate mixing occurs after 5 minutes mixing time, (2) the impellers of tanks impart sufficient energy to lift representative sediments from the bottom of the tank to the surface of the liquid, and (3) the practice of stirring 10 minutes prior to sampling is sufficient to insure that a representative sample may be drawn from the tank. (auth)

2017 (DOCKET-50128-4) TEXAS A AND M RESEARCH REACTOR. Measurement of the Void Coefficient in Core Loading Number 2. Technical Report No. 4. (Texas Engineering Experiment Station, College Station). Sept. 1963. 5p. Dep. CFSTI.

2018 (DOCKET-50128-5) TEXAS A AND M RESEARCH REACTOR. Continuous Stack Gas Effluent Monitoring System. Technical Report No. 6. (Texas Engineering Experiment Station, College Station). Sept. 1963. 7p. Dep. CFSTI.

A gaseous effluent stack monitoring system was developed, calibrated for the assay of ^{41}A, and installed. This system provides two channel continuous gamma photopeak or integral monitoring of radioactive gases in the building stack exhaust system. (auth)

2019 (DOCKET-50128-6) TEXAS A AND M RESEARCH REACTOR. Calculation of the Hot-Channel and Burnout Factors and the Burnout Ratio. Technical Report No. 8. (Texas Engineering Experiment Station, College Station). July 20, 1963. 35p. Dep. CFSTI.

The hot-channel factors, the burnout factor, and the burnout ratio for the Nuclear Science Center Reactor operating at a steady-state power level of five thermal megawatts were calculated. The overall hot-channel factors were found to be $K_w = 3.079$, $K_f = 5.116$, and $K_m = 2.672$ for the coolant temperature rise, the film temperature rise, and the internal metal temperature rise in the hot-channel, respectively. The burnout factor and the burnout ratio were found to be 3.966 and 11.00, respectively. (auth)

2020 (DOCKET-50128-7) TEXAS A AND M RESEARCH REACTOR. Results of the Critical Test Program for Loading Number 7. Technical Report No. 10. (Texas Engineering Experiment Station, College Station). Mar. 1964. 64p. Dep. CFSTI.

The core loading designated number 7 and the associated experimental facilities are described. The core basically consists of a 5 by 5 array loaded next to the thermal column. Experimental data for the core and the facilities are presented. (H.D.R.)

2021 (DOCKET-50128-8) TEXAS A AND M RESEARCH REACTOR. Damping Characteristics of the Shim-Safety Rods. Technical Report No. 11. (Texas Engineering Experiment Station, College Station). Mar. 1964. 11p. Dep. CFSTI.

The stopping characteristics of the boron–stainless steel alloy control rods were investigated in drop tests. The maximum stress on the control rod was estimated using results of rod acceleration versus position. Although no stress levels were found that would endanger the integrity of the control blades, it is recommended that a study be performed to improve the performance of the dash pots. (H.D.R.)

2022 (DOCKET-50128-10) TEXAS A AND M RESEARCH REACTOR. Design, Calibration, and Installation of a Large-Volume, Continuous Stack Gas-Effluent Monitor. Technical Report No. 9. (Texas Engineering Experiment Station, College Station). Oct. 1963. 8p. Dep. CFSTI.

A gaseous effluent monitoring system was developed and installed for continuous monitoring of building exhaust gases at the Nuclear Science Center Reactor Facility, Texas A & M University. The system provides two channels for continuous gamma photopeak or integral monitoring of gases and is comprised of a 3 in. by 3 in. NaI (Tl) gamma scintillation detector, a shielded 30 liter volume gas sampler with machined helical insert for gas flow control, an air pumping system, a transistorized dual channel gamma spectrometer, and a multipoint recorder. Linear calibrations of 2.42×10^{-9} μc/ml-cpm and 1.21×10^{-9} μc/ml-cpm were obtained for the detection of ^{41}A gas using photopeak counting and integral counting respectively. A sensitivity of 6×10^{-8} μc/ml corresponding to 25 net counts per minute which is twice background was observed for photopeak counting of ^{41}A. (auth)

2023 (DOCKET-50128-11) TEXAS A AND M RESEARCH REACTOR. Modification of the Startup Channel. Technical Report No. 13. (Texas Engineering Experiment Station, College Station). Oct. 1964. 7p. Dep. CFSTI.

Modifications to the startup channel in an attempt to reduce the noise level are described. The basic changes made were in shielding the pre-amplifier in a one-eighth inch thick steel box and in placing the pre-amplifier closer to the detector. The schematic of the new system and results obtained with it are presented. (H.D.R.)

2024 (DOCKET-50128-12) TEXAS A AND M RESEARCH REACTOR. Preliminary Design of a 1.5 MW Cooling System. Technical Report No. 14. (Texas Engineering Experiment Station, College Station). Dec. 1964. 7p. Dep. CFSTI.

The preliminary design and cost estimate of a 1.5 MW cooling system for the Nuclear Science Center are presented. This system cools only the pool water while the reactor heat is removed by natural convection flow through the core. (auth)

2025 (DOCKET-50128-13) TEXAS A AND M RESEARCH REACTOR. A Survey of Pool Linings for Swimming Pool Reactors. Technical Report No. 15. (Texas Engineering Experiment Station, College Station). Apr. 1965. 24p. Dep. CFSTI.

Because of leakage problems with the reactor pool lining, a survey was conducted to obtain the experiences of other pool reactors with various types of linings. Replies from operators of swimming pool reactors concerning the performance of organic coatings, tile, aluminum, and stainless or mild steel as pool linings are presented. (H.D.R.)

2026 (DOCKET-50128-14) TEXAS A AND M RESEARCH REACTOR. Investigation of Cracking and Leaking of Nuclear Reactor Pools. Technical Report No. 16. (Texas Engineering Experiment Station, College Station). Jan. 1964. 51p. Dep. CFSTI.

An investigation was undertaken to develop effective measures to prevent cracking and leaking of reactor pools of the type used at the Texas A and M reactor. Studies were conducted on the pool crack patterns, leakage, stresses, concrete properties, construction methods, and design aspects. It is concluded that the only practical solution to stopping the flow of water through the walls is to waterproof the pool interior. (H.D.R.)

2027 (DOCKET-50128-15) TEXAS A AND M RESEARCH REACTOR. Experimental Determination of the Source of Photoneutrons in a Water Moderated Nuclear Reactor. Technical Report No. 17. (Texas Engineering Experiment Station, College Station). Jan. 1966. 39p. Dep. CFSTI.

An experiment was performed which verified the presence of photoneutrons in a water moderated swimming pool reactor for long periods of time following shutdown. The gamma rays causing the photoneutrons were determined to be from ^{140}La in the 12.8 day ^{140}Ba to ^{140}La chain. This identification was made by measuring the half life of gamma ray peaks at 1.57 MeV and 2.49 MeV as 12.8 days. The experiment also verified that the photoneutrons are from the $D(\gamma,n)$ reaction utilizing the 0.015% of D_2O in natural water. This was done by varying, in steps, the D_2O concentration of a small volume of natural water near a single fuel element and observing the neutron population at each concentration. (auth)

2028 (DOCKET-50128-16) TEXAS A AND M RESEARCH REACTOR. The Measurement of Thermal Neutron Flux Distributions Through a Variable Water Gap and Graphite Slab. Technical Report No. 18. (Texas Engineering Experiment Station, College Station). June 1966. 16p. Dep. CFSTI.

Neutron flux distributions and reactivity changes were measured for graphite reflectors at various distances from the face of core loading 8-B. The optimum water gap between core and reflector was chosen to be 2 inches from the results obtained. (H.D.R.)

2029 (DOCKET-50128-17) TEXAS A AND M RESEARCH REACTOR. Results of the Critical Test Program for Loading Number 8-B. Technical Report No. 19. (Texas Engineering Experiment Station, College Station). Nov. 1966. 47p. Dep. CFSTI.

Core loading 8-B and associated experimental facilities are described. The core is a 5 by 5 array with the north-east corner, south-east corner, and center positions vacant. Experimental data from the critical test program are presented. (H.D.R.)

2030 (DOCKET-50128-18) TEXAS A AND M RESEARCH REACTOR. An Investigation of the Properties of Photoneutrons in Core. Technical Report No. 20. (Texas Engineering Experiment Station, College Station). May 1967. 12p. Dep. CFSTI.

The origin of an appreciable count rate in the startup channel following reactor shutdown was identified as photoneutrons produced in the water. Experimental data on the spatial and time dependent properties of this inherent neutron source are presented. The source strength is shown to be comparable to that of the external startup source used. (H.D.R.)

2031 (DOCKET-50128-19) TEXAS A AND M RESEARCH REACTOR. The Measurement of Thermal Neutron Flux Distributions Through a Variable Water Gap and a Void. Technical Report No. 22. (Texas Engineering Experiment Station, College Station). Sept. 1967. 11p. Dep. CFSTI.

Neutron flux distributions and reactivity changes were measured for a test void placed at various distances from the face of core loading 8-B. The results obtained are compared with results for graphite reflector test sections. (H.D.R.)

2032 (DOCKET-50184-16) NATIONAL BUREAU OF STANDARDS REACTOR. Operations Report No. 2, July-September 1968. (National Bureau of Standards, Washington, D. C.). Nov. 19, 1968. 24p. Dep. CFSTI.

2033 (GEAP-10010-21) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR DEVELOPMENT PROGRAM. Twenty-First Quarterly Report, May-July 1969. Pflasterer, G. R.; Becker, R. A. (comps.) (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Aug. 1969. Contract AT(04-3)-540. 62p. Dep. CFSTI.

Separate abstracts are included for each of the three sections presented. Topics discussed include: fuel fabrication; startup testing; and SEFOR operation and maintenance. (D.C.C.)

For abstracts of individual sections see: 2034-2036.

2034 (GEAP-10010-21, pp 6-23) TASK 9: FUEL FABRICATION. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation).

Fabrication of fuel rods for SEFOR is described. Porosity in fuel element welds is analyzed. Insertion of thermocouples into the fuel elements is described. (D.C.C.)

2035 (GEAP-10010-21, pp 24-53) TASK 10: STARTUP TESTING. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation).

Startup testing for the PuO_2-UO_2 fueled SEFOR is described. Initial loading critical approach calculations and measurements are analyzed. Reactivity with measurements of core materials are presented. (D.C.C.)

2036 (GEAP-10010-21, pp 54-8) SEFOR FACILITY. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation).

Operation and maintenance requirements for SEFOR during May to July 1969 are described. Testing programs and surveillance procedures are reviewed. (D.C.C.)

2037 (ORNL-TM-2698) BULK SHIELDING FACILITY QUARTERLY REPORT, APRIL-JUNE 1969. Tabor, W. H.; Hurt III, S. S.; Nixon, T. B. (Oak Ridge National Lab., Tenn.). Sept. 3, 1969. 31p. Dep. CFSTI.

The BSR operated at an average power level of 1839 kW for 51.7% of the time during April, May, and June of 1969. Water quality control in both the reactor primary and secondary cooling systems was very satisfactory. There were sixteen unscheduled shutdowns, nine of which were caused by shim rods dropping; three were caused by fast scrams initiated by the No. 3 safety channel (instrument trouble); one by an electrical power surge that originated in another area at the Laboratory; one by an electrical power outage because of an electical storm; and two by human error. Troubles experienced in the nuclear and process instrumentation and controls were: (1) failure of six shim-rod seat switches; (2) failure of three shim-rod magnets; (3) failure of chambers: the log-N chamber in chamber position C, the No. 3 safety chamber in chamber position D, and the No. 2 safety chamber in chamber position B; and (4) failure of one composite amplifier. The PCA was used in conducting annual experiments for university students. (auth)

2038 (ORNL-TM-2734) HIGH FLUX ISOTOPE REACTOR QUARTERLY REPORT, APRIL-JUNE 1969. McCord, R. V.; Corbett, B. L. (Oak Ridge National Lab., Tenn.). Sept. 24, 1969. 18p. Dep. CFSTI.

Operation and maintenance requirements for HFIR during April to June 1969 are presented. Revised design parameters and operation procedures are described. (D.C.C.)

2039 (RD/B/N-1189) AN ACCOUNT OF SUB-CRITICAL AND CRITICAL REACTIVITY MEASUREMENTS ON THE FIRST B.N.L. ZERO ENERGY REACTOR. Mountain, W.; Roberts, D. A.; Waterson, R. H. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Aug. 1969. 30p. Dep. CFSTI (U. S. Sales Only).

Results of prompt neutron decay constant and source jerk mea-

surements on a 1.8% enriched UO_2 fueled, graphite moderated and fully reflected assembly are described. The definition of a reactivity scale relative to source jerk measurements, the non-unique decay constant measured for a small core with a large reflector, and the analysis of decay constant measurements near critical are discussed. The excess reactivity measurement of the unperturbed core using the doubling time technique is described for the critical reactor. (14 references) (auth)

2040 INVESTIGATIONS OF ALUMINUM CANS OF USED NUCLEAR REACTOR IRT-2000 FUEL ELEMENTS. Krast, Kh. B.; Laivin'sh, M. E.; Byalobzheskii, A. V.; Tiliks, Yu. E. At. Energ. (USSR), 27: 286-9(Oct. 1969). (In Russian).

The investigations of cans of the nuclear reactor IRT-2000 fuel elements irradiated in-pile at the dose of 10^{20} neutron cm^2 for about 4 years showed that its metallic surface was covered with pits of 0.05 to 1.5 mm diameter, and the maximum depth of 0.05 mm. The corrosion rate was ~0.01 mm/year. The thickness of the anodic layer decreased 50%, and the diffusion of uranium fission products ^{137}Cs and ^{144}Ce in the element can was 5 mc. X-ray analysis showed the bayerite in the corrosion products. 11 references. (auth)

2041 FAST NEUTRON FLUX MEASUREMENTS OF RESEARCH REACTOR (TRIGA MARK-II) BY THRESHOLD REACTIONS AND CROSS SECTION MEASUREMENTS OF $^{204}Pb(n,n')^{204m}Pb$ AND $^{204}Pb(n,2n)^{203}Pb$ REACTIONS. Lee, Chul; Cho, Won Ji (Atomic Energy Research Inst., Seoul). J. Nucl. Sci. (Seoul), 9: 73-6(1969).

The measurement of fast neutron flux in the TRIGA MARK II is described by using $^{58}Ni(n,p)^{58}Co$ and $^{56}Fe(n,p)^{56}Mn$ reactions. Cross sections of $^{54}Fe(n,p)^{54}Mn$, $^{204}Pb(n,n')^{240m}Pb$, $^{204}Pb(n,2n)^{203}Pb$ are measured. 15 references. (auth)

2042 MITSUBISHI CRITICAL FACILITIES. Ogura, Shigeyoshi; Hayata, Kimihiko (Mitsubishi Atomic Power Industries, Inc., Tokyo). Mitsubishi Denki Giho, 43: 1159-66(Sept. 1969). (In Japanese).

Design requirements and materials utilized by Mitsubishi Atomic Power Industries in constructing water cooled and moderated critical assemblies are described. (auth) (NSA of Japan)

Rocket and Space Reactors

Refer also to abstract 519.

2043 (N-69-35817) COMPARISON OF TUNGSTEN AND DEPLETED URANIUM IN MINIMUM-WEIGHT, LAYERED SHIELDS FOR A SPACE POWER REACTOR. Lahti, Gerald P.; Herrmann, Paul F. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Sept. 1969. 17p. (NASA-TM-X-1874; E-5079). CFSTI.

The weights of layered spherical shields for a fast spectrum 2.2-megawatt-thermal nuclear space power reactor have been calculated for two candidate γ shield materials, W and depleted U, using natural LiH as the material for neutron shielding. Each shield configuration was optimized to a dose rate constraint of 2 millirem per hour at 20 meters. A one-dimensional discrete ordinates transport program and a steepest-descent method optimization program were used. (auth) (STAR)

2044 (UCRL-50004-67-1, pp 47-82) REACTOR, SYSTEM, AND COMPONENT ENGINEERING. (California Univ., Livermore. Lawrence Radiation Lab.).

CORROSION LOOPS—design of high temperature liquid lithium, for heat pipe alloy testing
HEAT PIPES—fabrication technique development for 2000°K tungsten-molybdenum alloy
LOOPS—operation of low temperature liquid NaK, for testing reactor space power system pumps
MOLYBDENUM ALLOYS AND SYSTEMS—Mo-W, fabrication technique for 2000°K heat pipe
NUCLEAR AUXILIARY POWER SYSTEMS—design concepts for 300 KW(e) and 10 MW(e) space, using Rankine cycle power conversion
—radiator designs for SPR-6, analysis of direct-condensing tube-fin and heat pipe
POWER CYCLES—specific mass of 300 kW(e) and 10 MW(e) Rankine system, reactor coolant outlet temperature for minimum, (T)
PUMPS—testing of reactor space power system, low temperature liquid NaK loop for
RADIATORS—design concepts for SPR-6 system, analysis of direct-condensing tube-fin and heat pipe
REACTORS, POWER—design concepts for 300 kW(e) and 10 MW(e) space, using Rankine cycle power conversion (H.D.R.)

Marine and Portable Power Reactors

2045 (N-69-35723) POTENTIAL OF NUCLEAR POWER FOR HIGH-SPEED OCEAN-GOING AIR-CUSHION VEHICLES. Rom, Frank E.; Kascak, Albert F. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Sept. 1969. 34p. (NASA-TM-X-1871). CFSTI.

The use of nuclear powerplants based on nuclear aircraft technology to power ocean-going air-cushion vehicles has been investigated. Because aircraft nuclear powerplants might be an order of magnitude lighter than current nuclear marine plants, the performance of nuclear air-cushion vehicles is dramatically altered. Instead of vehicles limited to short ranges and speeds of about 80 knots, they become vehicles with virtually unlimited range and speeds in the range of 100 to 200 knots. The study considers vehicles with gross weights of 1000 to 10,000 tons and clearance heights from 10 to 40 feet, which are sufficient to clear ocean waves 80 to over 90 percent of the time. The cargo capacity ranges from 20 to 50 percent of the gross weight. Direct operating costs are 2 to 5 cents per ton-mile and are independent of the distance travelled. (auth) (STAR)

2046 REACTOR INSTRUMENTATION AND SAFETY SYSTEMS IN THE FIRST NUCLEAR-POWERED SHIP. Kobayashi, Michiyuki (Japan Nuclear Ship Development Agency, Tokyo). Genshiryokusen, No. 67, 1673-80(May 1969). (In Japanese).

The reactor instrumentation in the first nuclear-powered ship is classified in two groups: nuclear instrumentation, and process instrumentation including temperature, pressure, and flow-rate. The requirements, in common for the two, are extremely high reliability and long endurance, because of the necessary safety. All the values of measurement are converted to electrical signals, and indication, recording, announcement, and control are electrical. The power sources are duplicated to prevent accidents due to power-supply failure; power sources for the instrumentations are mostly separate from the ordinary power supplies, to inhibit adverse effects from the fluctuation in voltage. (NSA of Japan)

2047 MODEL OF THE REACTOR-CONTAINMENT VESSEL AND REACTOR ROOM WITH VARIOUS SYSTEMS FOR THE FIRST NUCLEAR-POWERED SHIP. Kawamura, Syohei (Japan Nuclear Ship Development Agency, Tokyo). Genshiryokusen, No. 67, 1681-2(May 1969). (In Japanese).

Full-size models of the reactor-containment vessel and the reactor room with various systems were constructed to study their arrangement in the first nuclear-powered ship. The arrangements of the containment vessel and the reactor room, and of the respective systems, and also the ideas in construction of the models, the test items of the maintenance and repair and the results are described. (NSA of Japan)

2048 MAIN COOLING SYSTEM FOR REACTOR PLANT IN FIRST NUCLEAR POWERED SHIP. Kurosawa, Akira (Japan Nuclear Ship Development Agency, Tokyo). Genshiryokusen, No. 67, 1655-7(May 1969). (In Japanese).

The main cooling system for the reactor plant in the first nuclear-powered ship is described. The primary cooling system is made of two loops, running in parallel through the reactor. In each loop a steam generator and a cooling-water pump are installed, and in one of them a pressurizer is also installed. Main features of the primary cooling system are listed. The reactor consists of the reactor vessel, fuel assemblies, core-support structure, and control rods. Design parameters are listed. (NSA of Japan)

2049 AUXILIARY SYSTEMS FOR REACTOR PLANT IN FIRST NUCLEAR-POWERED SHIP. Seino, Kazuo (Japan Nuclear Ship Development Agency, Tokyo). Genshiryokusen, No. 67, 1568-1665(May 1969). (In Japanese).

The reactor plant in the first nuclear-powered ship has the following auxiliary systems: to control the volume of coolant; to remove the residual heat; to cool the associated facilities; to cool the reactor in emergency; and to sample coolant water. Components of each system are listed. (NSA of Japan)

2050 GENERAL DESCRIPTION OF THE FIRST NUCLEAR SHIP "MUTSU." Sasaki, Shuichi (Japan Nuclear Ship Development Agency, Tokyo). Nucl. Eng. Design, 10: 123-5(June 1969).

The Mutsu, the first nuclear ship of Japan, is a cargo ship of 8300 gross tons. Steam for the 10,000 shp main engine is supplied by a 36 MW(t) pressurized water reactor. Service speed is 16.5 knots. The ship and reactor power plant are briefly described, and design parameters are tabulated. (H.D.R.)

2051 THERMO-HYDRAULIC MODEL TEST OF THE FIRST NUCLEAR SHIP REACTOR IN JAPAN. Takada, Yoshi; (Ship Research Inst., Tokyo); Yokomura, Takeyoshi; Kurosawa, Akira. Nucl. Eng. Design, 10: 126-47 (June 1969).

A series of thermo-hydraulic model tests were carried out to confirm that the first nuclear ship reactor in Japan was properly designed. The major test models were a half-size core structural model, a full-size fuel assembly model and a half-size steam generator plenum model. The measured results were compared with the design calculation of the reactor. Most of the calculated results were found to be in good agreement with experiment. However, the pressure drop in the reactor vessel was found to be overestimated, and a necessary correction was made on the system design. Also flow velocity distribution was found to be much more distorted than expected in the fuel assembly, and an appropriate design modification was made in the lower end plate. Flow coastdown in the primary loop and coolant mixing in the fuel assembly are also discussed. (auth)

2052 SHIELDING EXPERIMENT FOR THE FIRST NUCLEAR SHIP IN JAPAN. Kawai, Y. (Japan Nuclear Ship Development Agency, Tokyo); Kataoka, I. Nucl. Eng. Design, 10: 169-86 (June 1969).

The experimental investigations on the marine reactor shielding in Japan were initiated in 1957 as well as theoretical studies. Among others, a series of extensive shield mockup experiments were performed through 1965 to 1967 in connection with the final design of the First Nuclear Ship in Japan. These include mockups of the primary shielding both in the core radial direction and in obliquely upwards direction, secondary shield samples with cylindrical penetrations and samples having gaps between shield blocks. After a brief historical survey of relevant works, the mockup experiments for the side primary shield, the instrumentation tubes arranged in the reactor shield tank, and gaps of thin rectangular slit formed between lead slabs, concrete blocks, or both, are described. The results thus obtained have established the applicability of design procedures to the shield configuration which is to be used in the actual shield under construction. (auth)

2053 SHIP DESIGN OF THE FIRST NUCLEAR SHIP IN JAPAN Oi, Hiroshi; Tanigaki, Kazuo (Japan Nuclear Ship Development Agency, Tokyo). Nucl. Eng. Design, 10: 211-19 (June 1969).

The guarantee of safety in the Japan nuclear ship is a dominant design criterion; this means: not-to-sink, anti-collision, anti-grounding, good steering apparatus, fire protection, auxiliary propulsion and safe reactor control under all conceivable ship motions and in cases of malfunctioning of auxiliary equipments. This ship is provided with a reactor containment vessel safeguarding against release of fission products in the case of the maximum credible accident, and with biological shield structures of concrete, lead and polyethylene. The liquid and solid radioactive waste would not be discharged on the sea, but stored in tanks and stores. Their capacity should cover six-months voyage. (auth)

2054 ESTIMATION OF THE EXTREME VALUES OF WAVE-INDUCED SHIP MOTIONS AND ACCELERATIONS FOR THE FIRST NUCLEAR SHIP IN JAPAN. Takaishi, Yoshifumi; Yamanouchi, Yasufumi (Ship Research Inst., Tokyo). Nucl. Eng. Design, 10: 220-30 (June 1969).

For the purpose of predicting extreme values of ship motions and accelerations induced by waves on the First Nuclear Ship in Japan, a model test in the Ship Research Institute's experimental basin as well as theoretical computations were carried out. Firstly, the response character of the ship in regular waves was obtained and the influences of wave directions as well as ship speed upon the responses were investigated. Secondly, the power spectrum and the cumulative energy density of the responses in certain given irregular waves were obtained by two kinds of methods, the one experimental and the other theoretical. The short-term probability distribution of the ship responses in various sea states were determined and the extreme values expected to be encountered in the most severe sea state were estimated. Finally, the long-term distribution of the responses was calculated by using the short-term probability distributions of the above mentioned responses and the statistical probability of occurrence of sea state in the northern North Atlantic Ocean, from which the extreme values expected to be encountered for periods of time as long as one year or all her life could be estimated. The estimated extreme values were compared with those obtained by various methods already derived. As a result, it is recognized that the probable extreme values of accelerations and ship motions are within the design standard of safety for the nuclear ship. (auth)

2055 CONTROL SYSTEMS AND TRANSIENT ANALYSIS. Fuji-i-e, Yoichi (Osaka Univ.). Nucl. Eng. Design, 10: 231-42 (June 1969).

Described are the part of the reactor system which has an intimate relation to reactor operation and the functions of the control system and the safety system. Transient behaviour of the reactor and the steam generator under load change and transient behaviour of the steam generator due to ship motion are discussed. (auth)

2056 FLOW COASTDOWN IN CENTRIFUGAL PUMP SYSTEMS. Kokomura, Takeyoshi (Ship Research Inst., Tokyo). Nucl. Eng. Design, 10: 250-8 (June 1969).

An analytical method to estimate coastdown behaviour in indirect cycle water-cooled reactor systems is described. This method is applicable to a system with one reactor and any number of centrifugal pumps. The detailed information of the pump characteristics is not required. Numerical results of the analysis are presented and compared with experiments performed on a reactor model system. Agreement between the analysis and experiment is satisfactory in a case, where all pumps lose the power simultaneously. In another case of one pump power failure, observed flow rate is found to be in a range predicted by analysis. (auth)

Reactor Theory

Kinetics

Refer also to abstract 1723.

2057 (BMwF-FBK-69-24) CALCULATION OF CRITICAL QUANTITIES FOR NEUTRON TRANSPORT THEORY IN PLANE GEOMETRY. PART I. Winkler, H. (Karlsruhe Univ. (West Germany). Institut fuer Struktur der Materie). June 1969. 73p. (In German). Dep. CFSTI (U. S. Sales Only).

A solution by W. Kobink in P_L-approximation for the stationary monoenergetic Boltzmann equation in plane geometry and for linear anisotropic scattering using the spherical harmonics method (①, ②, ③)) is described. This solves the critical problem for a homogeneous slab of finite thickness. In the limit $L \to \infty$ an exact solution which is very suitable for numerical calculations is derived. This procedure represents an enlargement of the critical problem of a slab to linear anisotropic scattering. In the special case of isotropic scattering the numerical results are equal to those given by R. Zelazny, G. Mitsis and J. Hejtmanek (⑦, ⑧, ⑨)). 11 references. (auth)

2058 (EURFNR-652) MODELS, METHODS, AND DIGITAL COMPUTER PROGRAMS FOR ANALYSES IN REACTOR DYNAMICS WITH EMPHASIS ON FAST BREEDER REACTORS AND COMPRESSIBLE SINGLE-PHASE COOLANTS. Hornyik, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Dec. 1968. 111p. (KFK-799; EUR-3964). Dep. CFSTI.

Work performed under United States–Euratom Fast Reactor Exchange Program.

The models used in describing the dynamic behavior of fast breeder reactors are described in detail. The thermohydraulic and neutronics models are discussed; applicable equations are given. The program computes, as needed, the: heat source distribution; heat flow and temperatures; coolant hydraulics; and neutron kinetics and feedback. The complete program is shown by a flow diagram; computations performed by each subroutine are listed. Input/output format is listed; error messages, storage requirements, and computing times are described. A sample problem is included. The program and subroutines are written in FORTRAN IV and have been used on the IBM 7094 and 360/65. 15 references. (M.L.S.)

2059 (RISO-M-926) N-SOUSI: A 2-DIMENSIONAL HETEROGENEOUS MULTIGROUP-PROGRAMME. Pedersen, J. (Danish Atomic Energy Commission, Risoe. Research Establishment). July 1969. 24p. Dep. CFSTI (U. S. Sales Only).

The computer program N-SOUSI, an N-group SOUrce-SInk-code, for calculating flux distribution and criticality of a cylindrical reactor with cylindrical fuel elements and control elements placed at arbitrary positions is described. 5 references. (auth)

2060 APPLICATION OF SYNTHESIS METHODS TO THE CALCULATION OF FAST TRANSIENTS. Eletti, G. F.; Ricci, A.; Romanacci, R. (CNEN, Bologna). Ing. Nucl., 10: No. 3, 29-36 (May-June 1969). (In Italian).

An analytic description of fast transients in water cooled power reactors is synthesized, and a computer program, based on these equations, is described. The synthesis of the time-dependent diffusion equations is based on modal analysis techniques. Results

of flux calculations are shown graphically. Use of modal analysis methods for the analytic description of power transients is discussed; a sample problem illustrates the techniques. (M.L.S.)

2061 ANALYTICAL THEORY OF RESONANCE ABSORPTION OF NEUTRONS IN HETEROGENEOUS REACTOR SYSTEMS WITH CYLINDRICAL GEOMETRY. Slipicevic, Kerim F. Publ. Elektroteh. Fak. Univ. Beogradu, Ser. Mat. Fiz., No. 243, 1-36(1969).

Equations for the absorbed neutron current are derived in terms of the neutron source densities. Expressions for the neutron penetrability factors are derived. The effective resonance integral for the neutron current equations is then determined in terms of the penetrability factors. 26 references. (M.L.S.)

2062 TRANSIENT TEMPERATURES IN REACTOR CHANNELS INDUCED BY SIMULTANEOUS CHANGES IN THE POWER LEVEL, THE COOLANT SPEED, AND THE COOLANT INLET TEMPERATURE. Axford, Roy A. (Los Alamos Scientific Lab., N. Mex.). Nucl. Eng. Design, 10: 55-71(May 1969).

A new method is developed for computing transient temperature fields in cylindrical reactor channels when the relative fuel power density, the coolant speed, and the channel inlet temperature are arbitrarily specified functions of time. Through the use of Hankel transforms, numerical instabilities inherent in finite difference approximations of spatial derivatives are avoided. Solutions of high order systems of ordinary differential equations in the time coordinate are efficiently obtained by a computational algorithm based upon the concept of Lie series. The method is particularly easy when the heat transfer coefficient is a weak function of the coolant speed, as for liquid metals. 2 references. (auth)

2063 DETERMINING THE CRITICAL PARAMETERS OF HOMOGENEOUS REACTORS BY A METHOD OF COMPENSATED PERTURBATIONS. Stumbur, E. A.; Sazonov, S. P. At. Energ. (USSR), 27: 55-7(July 1969). (In Russian).

A general theoretical analysis of the dependence between the critical loading G and the critical volume V of an arbitrary homogeneous reactor shows the necessity of introducing two integral parameters: a leakage factor and an index of the efficiency of the fissionable material. An arbitrary function G(V) for a reactor of any composition is determined by the ratio of the two above parameters. A volume integral of the reactivity is introduced as an analog of the leakage factor. With small, mutually compensated perturbations of the reactor, the reactivity integral does not change, and a variational equation can be derived. Thus, conditions of criticality can be described for arbitrarily small changes in reactor composition, size or configuration. Integration of these differential equations gives general analytical formulas which in a number of cases can be applied over a wide range of changes of mutually related critical parameters. The critical radius as a function of the densities of the active zone and reflector is considered as an example. The reflector thickness is changed by a small variation of the external radius and by a variation in radius of the active zone in such a way that the reactor remains critical. The critical radius of a homogeneous sphere as a function of its composition is also considered. Critical radii for homogeneous reactors can be determined by this method with a minimum of initial information. (TTT)

2064 ANALOG/HYBRID SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS IN THE NUCLEAR INDUSTRY. Vichnevetsky, R. (Electronic Associates, Inc., Princeton, N. J.). Simulation, 11: 269-81(Dec. 1968).

Methods for solving the partial differential equations which occur in the simulation of nuclear power plants are outlined; the application of the hybrid computer to these solution techniques is discussed. Assumptions and equations are given. Finite difference and parallel-modal methods of solution are described; the attainable accuracy between these two methods is evaluated. Methods for representing control rods in core simulation are described. Continuous-space discrete-time methods and application of the hybrid computer to these methods are detailed. Application of multiplexing techniques to solution of reactor problems is discussed. 51 references. (M.L.S.)

Dynamics

2065 (ANL-7565) WEIGHTED-RESIDUAL METHODS IN SPACE-DEPENDENT REACTOR DYNAMICS. Fuller III, Edward L. (Argonne National Lab., Ill.). Apr. 1969. Contract W-31-109-eng-38. 100p. Dep. CFSTI.

Thesis. Submitted to Univ. of Arizona, Tucson.

A study of approximate methods for the solution of problems in space-dependent nuclear-reactor dynamics is presented. It is shown that these approximate methods can all be thought of as applications of the method of weighted residuals. In each method, a trial solution is formed for the neutron flux. The trial solutions are expansions in known spatially dependent functions called trial functions. Each approximate method differs from the others in the manner in which its trial functions are chosen. The undetermined time-dependent functions, called amplitude functions, are then found by using the weighted-residual procedure known as the method of undetermined functions to derive the so-called multimode kinetics equations, which are first-order, ordinary differential equations in time. The multimode kinetics equations are then integrated using the method of undetermined parameters. An iterative method, which uses the method of undetermined functions for both spatial and temporal integrations, is described. It eliminates the need for choosing accurate trial functions because it finds a solution which is independent of the initial choice of trial functions. A simple example is solved to illustrate the method. Several possible applications of the method are indicated. Some numerical results are reported for continuous-synthesis and multichannel-synthesis approximations. Several choices of weighting functions are compared. Conclusions are drawn regarding the roles of the trial functions and the weighting functions in obtaining accurate solutions. 67 references. (auth)

Experimental Applications

2066 (CTH-RF-17) PULSED NEUTRON METHOD APPLIED TO THE INTERACTION BETWEEN TWO MODERATORS. Grosshoeg, Gudmar (Chalmers Tekniska Hogskola, Goteborg (Sweden). Institutionen for Reaktorfysik). July 1969. 49p. Dep. CFSTI (U. S. Sales Only).

The possibility to use the pulsed neutron method in the study of two interacting moderators was investigated. It was found both through theory and experiments that transport effects have a dominant influence on the decay constants. The decay constants were measured in a system consisting of two polyethylene discs separated along the symmetry axis. The discs had a diameter of 18 cm. Two series were measured. In the first the discs had a height of 2.2 cm. They were separated by a distance that was varied up to 13.2 cm in steps of 2.2 cm. In the second the height of the discs was 4.4 cm, the maximum separation distance was 8.8 cm, and the step length was the same as in the first series. The experiments covered a decay constants range 10,000–40,000 s^{-1}. Reliability of the measurement was checked in the limit of zero separation distance and in the limit of no interaction. It was found that in all experiments, with the exception of those in the limits, the decay constants were drifting in time. Therefore they cannot, be looked upon as reliable pseudomodes. The results found can be extended to include all experiments with the pulsed neutron method applied to moderators containing cavities or having concave boundaries. A method to eliminate the drifting effect through the incorporation of absorbers in the cavities is suggested. (auth) (Sweden)

2067 (DOCKET-50128-9) TEXAS A AND M RESEARCH REACTOR. Calculation of the Infinite Multiplication Factor for Fuel Elements at Various Water Spacings. Technical Report No. 12. (Texas Engineering Experiment Station, College Station). June 1964. 8p. Dep. CFSTI.

The k_∞ for stored, unirradiated fuel elements in water was calculated using heterogeneous diffusion theory and using the Boltzmann equation. Lattice spacings of at least 6 in. were determined to be safe in the event of flooding of the storage room. (H.D.R.)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 259, 260, 266–268, 272, 319, 353, 369, 394, 395, 397, 402–405, 455, 474, 476, 940, 941, 949, 967, 1047, 1049, 1056, 1060, 1061, 1073, 1076, 1079, 1099, 1102–1104, and 1963.

2068 (NP-18021) VERIFICATION OF THE URANIUM AND PLUTONIUM MEASUREMENTS ON A BATCH OF DISSOLVED REACTOR FUEL. Moeken, H. H. Ph.; Bokelund, H. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). June 1969. 19p. (ETR-235). Dep. CFSTI (U. S. Sales Only).

Empirical equations are presented which describe the U depletion and the Pu build-up in irradiated reactor fuel as functions of the U and Pu isotopic composition. The relationships are valid for fuel exposed in nuclear reactors using highly enriched, natural or slightly enriched U. The application of these equations for the independent verification of the measurements of the U and Pu concentration and isotopic composition, performed on dissolved batches

of spent fuel is described. An estimate is given of the ^{237}Np production in highly enriched U. (9 references) (auth)

2069 (WASH-1142) REACTOR FUEL BURNUP CALCULATIONS. An Annotated Bibliography of Selected Literature. Inman, Guy M. (comp.) (Office of Safeguards and Materials Management (AEC), Washington, D. C.). Oct. 15, 1969. 32p. Dep. CFSTI.

A total of 155 references to unclassified reports and published literature on nuclear fuel burnup is included. The material was taken from that appearing in Nuclear Science Abstracts from January 1, 1965 to July 30, 1969. The references are arranged by issuing agency with the latest work appearing first. Personal author and report number indexes are provided. The report number index indicates, for each report, the source through which the publication is made publicly available. (auth)

2070 DISPERSIONNYE TEPLOVYDELYAYUSHCHIE ELEMENTY YADERNYKH REAKTOROV. (Nuclear Reactor Dispersion Fuel Elements). Samoilov, A. G.; Kashtanov, A. I.; Volkov, V. S. Moscow, Atomizdat, 1969. 584p.

Dispersion fuel elements, their properties and applications are analyzed. Data are given on the construction of dispersion fuel elements (rods and laminated cores) their assembly, mechanical and physical properties, control and test, and radiation stability. Construction materials (Al, Zr, Ni, and their alloys, and high-melting metals Nb, Ta, Mo, and W) are discussed as well as fission materials (uranium with oxide, carbide, nitrogen, silicon and sulfur and plutonium compounds with oxygen). Extensive references are included for each chapter. (R.V.J.)

2071 PENETRATION SEALS AND NUCLEAR SAFETY. Rink, C. H. Power Eng., 73: No. 10, 52-4(Oct. 1969).

Tests for cable penetration seals of reactor containment structures are described. The performance of epoxy seals is analyzed. (D.C.C.)

2072 TECHNICAL AND ECONOMIC PROBLEMS IN THE USE OF FUEL ELEMENTS IN NUCLEAR POWER STATIONS. Schenk, Herbert (Kernkraftwerk, Obrigheim, Ger.). At. Strom, 15: 146-51(Sept. 1969). (In German).

The fuel cycle is discussed from the viewpoint of the operator of nuclear power stations. A review is given of the different stages of the fuel cycle and its problems. Fuel costs are itemized and important features of the energy related costs are discussed. The possibility of adapting the fuel cycle to the operation schedule of nuclear power stations is discussed. (auth)

2073 PRESSURE TUBES FOR NUCLEAR REACTORS. Heibling, W. (to Sulzer Brothers Ltd.). Canadian Patent 818,148. July 15, 1969. Priority date Jan. 28, 1964, Switzerland.

A more efficient method is proposed for circulating the coolant in the pressure tubes of a nuclear reactor. The coolant, supplied at one end, is conducted to the center of the reactor core by a channel containing no fissionable material. From the center it is there conducted into channels which contain fuel. These channels lead in part to one end and in part to the other end of the pressure tube resulting in a more uniform heat transfer than having the coolant enter at one end and leave at the other. Finally the heated coolant is withdrawn at both ends of the pressure tube after passing through these channels. The coolant flow apparatus thus consists of an outer pressure-resistant shell with two tubes within each extending from a separate end toward the middle. Each of these tubes defines an inner axial flow path within that tube and further defining with the shell an outer annular flow path outside that tube. Each of the outer flow paths has access to a separate one of the inner flow paths at the adjacent ends of the tubes. There is a separate coolant inlet means connecting with the outer flow paths adjacent to the ends of the shell and separate coolant outlet means connecting with each of the inner flow paths adjacent to the ends of the shell. A body of fissionable material is contained within each tube. Radiation shielding means are disposed within each of the tubes between the fuel body within that tube and the coolant outlet means connecting with the inner flow path defined by that tube. (F.S.A.)

2074 NUCLEAR REACTOR WITH PARTIAL MODERATOR DUMP. MacKay, I. N. (to Canadian General Electric Co. Ltd.). Canadian Patent 811,350. Apr. 22, 1969.

An arrangement is described whereby the dump tank surrounds the calandria up to a certain height and the two are connected by large dump ports. The advantage is that a partial shutdown may be effected quickly by causing only 20 to 50% of the moderator to flow into the dump tank. If complete shutdown is required the balance of the moderator flows more slowly into a storage tank. An advantage of this plan is that the portion of the moderator in dump tank may be restored to the calandria before xenon poison-out occurs and reactor started up again within about half an hour instead of waiting 24 to 36 hours for natural decay of Xe. A system of pumps, valves, and suitable connecting pipes allows control of helium pressure so that the above moderator flows may be carried out under close control. (F.S.A.)

2075 TUBULAR FUEL ELEMENT FOR A NUCLEAR REACTOR. Margen, P. H. E. (to Aktiebolaget Atomenergi). Canadian Patent 818,149. July 15, 1969. Priority date July 24, 1964, Sweden.

The fuel element contains vertical water and steam coolant channels with a nuclear fuel body between these two. Means are provided for passing water upward through the water coolant channel so as to produce steam which then passes downward through the steam coolant channels as superheated steam. An improvement consists of providing a heat-insulating layer on part of the fuel defining the water coolant channel so as to direct the major part of the fission heat toward the steam coolant channel. The heat-insulating layer is so arranged as to provide the best heat insulation in the upper portion of the water coolant channel where the water has its lowest cooling capacity. A similar heat-insulating layer is provided on the fuel defining the steam coolant channel so as to direct the major part of the fission heat toward the water coolant channel with the layer being so arranged as to provide the best heat insulation in the lower portion of the steam coolant channel where the steam has its lowest cooling capacity. The fissile fuel consists of a cylinder having its peripheral surface water cooled and having several steam-cooled channels parallel to its axis. The heat-insulating layer consists of a gas-filled space between the surface of the fissile fuel and a protective coating on its surface. (F.S.A.)

2076 GRIPPER FOR A LOADING MACHINE OF A NUCLEAR REACTOR. Johnsson, E. B.; Froman, K. G. E. (to Aktiebolaget Atomenergi). Canadian Patent 816,586. Priority date May 24, 1965, Sweden.

The device consists of a frame having on its lower portion at least two lifting hooks which can be moved between an inoperative position and an operative position in which they can engage the upper portion of a fuel element which is to be lifted out of, or lowered into the reactor. An operating member is movable in the frame and is secured to a wire belonging to the loading machine. The operating member and the frame are interconnected by means of a groove and pin so that a lowering and subsequent lifting of the operating member relative to the frame produces a rotation by a predetermined angle relative to the frame. This operating member is provided with two sets of shoulders to engage the lifting hooks. There is a blocking means to prevent a longitudinal movement of the operating member in the frame. The blocking means contains a part extending radially of the frame to be actuated by a narrow portion of the fuel element channel so as to release the operating member. (F.S.A.)

GENERAL

2077 (AEC-tr-6872/2) COMPUTER ELEMENTS AND SYSTEMS. Collection of Papers Issues Nos. 20–23, 1966. Translation of Vychislitel'nye Sistemy, Nos. 20, 21, 22, 23, 1966. 333p. (TT-69-55012/2; IPST-Cat.-5080-5083). Dep. CFSTI.

2078 (GA-8868) TAC2D: A GENERAL PURPOSE TWO-DIMENSIONAL HEAT TRANSFER COMPUTER CODE. User's Manual. Petersen, J. F. (Gulf General Atomic, Inc., San Diego, Calif.). Sept. 6, 1969. Contract AT(04-3)-167. 158p. Dep. CFSTI.

TAC2D is a code for calculating steady-state and transient temperatures in two-dimensional problems by the finite difference method. It is written entirely in Fortran V. The configuration of the body to be analyzed is described in the rectangular, cylindrical or circular (polar) coordinate system by orthogonal lines of constant coordinate called grid lines. The grid lines specify an array of nodal elements. Nodal points are defined as lying midway between the bounding grid lines of these elements. A finite difference equation is formulated for each nodal point in terms of its capacitance, heat generation and heat flow paths to neighboring nodal points. A system of these equations is solved by an implicit method which is the most efficient known at this time. TAC2D has been assigned operational status. The machine requirement is a 65K Univac 1108, or equivalent. In addition to input-output a maximum of four and a minimum of no tapes are required depending upon the code options being used. The operating system under which the code has been successfully used is EXEC II as modified for Gulf General Atomic. Running time depends upon the size of the problem and is not easily defined. (auth)

2079 (LA-4125) ARCHEOLOGICAL INVESTIGATIONS AT THE U.S. ATOMIC ENERGY COMMISSION'S NEVADA TEST SITE AND NUCLEAR ROCKET DEVELOPMENT STATION. Worman, Frederick C. V. (Los Alamos Scientific Lab., N. Mex.). Mar. 10, 1969. Contract W-7405-eng-36. 201p. Dep. CFSTI.

The archeology of southeastern Nye County, Nevada, which contains both the Nevada Test Site and the Nuclear Rocket Development Station was investigated. The biology, geology, and history of the NTS are discussed briefly. Then each of 17 archeological sites is described as to location, formation, and contents of archeological interest. These descriptions are illustrated with numerous photographs of the sites and the artifacts found therein. (L.C.L.)

2080 (LMEC-69-8) BAYESIAN STATISTICAL MODEL THEORY FOR MECHANICAL SYSTEMS. Walter, J. P. (Atomics International, Canoga Park, Calif. Liquid Metal Engineering Center). Aug. 31, 1969. Contract AT(04-3)-700. 94p. Dep. CFSTI.

The experiment sequencing problem is restated as an optimization problem, the object of which is to maximize information gained from experimentation; numerous candidates for an information gain function are introduced. Sequential Bayes estimation procedures are discussed for both parametric and empirical applications, where the methods of Hammond, Richardson, and Rutherford are presented. Examples include: (1) an instance of sequential Bayes point estimation on the basis of computer-simulated Gaussian data, and (2) implementation of a technique for actual metallurgical experimental data, the errors of which are postulated to be Weibull-distributed. (auth)

2081 (ORNL-4417) REPRESENTATION OF A STOCHASTIC PROCESS BASED ON ITS MEAN VALUE. Nagabhushanam, K.; Uppuluri, V. R. Rao (Oak Ridge National Lab., Tenn.). Oct. 1969. Contract W-7405-eng-26. 19p. Dep. CFSTI.

Let $\varphi(S)$ be a bounded measure defined on the Borel subsets S of W (a bounded subset of reals). A collection of random variables $\{Z(S)\}$ is said to be a first order spectral process, with spectral measure $\varphi(\cdot)$, whenever $E[Z(S)] = \varphi(S)$ and $Z(S_1) + Z(S_2) = Z(S_1 \cup S_2)$, whenever S_1 and S_2 are disjoint. The principal result of this paper is the following theorem: If the mean function $m(t)$ of a stochastic process $X(t)$ is given by $m(t) = \int_W f(t,\lambda)\, d\varphi(\lambda)$, $t = 0, \pm1, \pm2, \ldots$, (and certain mild conditions are satisfied), then there exists a first order spectral process $\{Z(S)\}$, with spectral measure $\varphi(S)$, such that $X(t) = \int_W f(t,\lambda)\, dZ(\lambda)$, $t = 0, \pm1, \pm2, \ldots$, and conversely. (auth)

2082 (ORNL-4437, pp 57-9) ORGANIC CHEMISTRY. (Oak Ridge National Lab., Tenn.).

Developments are reported for studies on: preparation and deamination of 5-exo-phenyl-5-hydroxy-2-exo-norbornylamine and 5-endo-phenyl-5-hydroxy-2-exo-norbornylamine; deamination of 3-exo- and 3-endo-phenyl-^{14}C-3-hydroxy-2-endo-norbornylamines; and degradation of 2-exo-norborneol-^{14}C. (P.C.H.)

2083 (ORNL-TM-2666) THE HIGH RESOLUTION MICROSCOPY PROGRAM, 1968. Welton, T. A.; Worsham, R. E.; Mann, J. E.; Richardson, E. G. Jr.; Slaughter, G. G.; Ziegler, N. F. (Oak Ridge National Lab., Tenn.). Nov. 1969. Contract W-7405-eng-26. 31p. Dep. CFSTI.

The activities of the Program for High Resolution Microscopy at ORNL are described in two papers adapted from annual progress reports of the groups involved. The first paper presents a detailed analysis of the performance of the transmission electron microscope from the standpoint of structure determination of biological molecules. A single figure of merit, the information content of the final data, is computed from the parameters that define the system. The second paper reports the experimental results in the development of the 150 kV and 750-kV power supplies, the field emission source, and the superconducting lenses. (auth)

2084 (RISO-M-951) HYBRID-COMPUTER CONTROL AND MONITOR INTERFACE. Hoejberg, K. Soee (Danish Atomic Energy Commission, Risoe, Research Establishment). Sept. 1969. 8p. Dep. CFSTI (U. S. Sales Only).

The principle of an interface system for the analog computer (Electronic Associates EAI 680) and a 12-bit digital computer (Digital Equipment Corporation PDP 8) is described. The control hardware concerned is used for digital computer control of the analog computer, including analog and logic element mode selection, computation of unit address selection and time scale control. The monitor hardware described makes it possible to read out the analog computer elements via a digital voltmeter by means of a digital computer program. (Denmark)

2085 (SC-RR-69-559-A) TRANSIENT TEMPERATURE DISTRIBUTIONS IN A RADIATING SPHERE. Abrams, M. (Sandia Labs., Albuquerque, N. Mex.). Sept. 1969. 36p. Dep. CFSTI.

A numerical method is used to calculate the surface and interior temperatures of a sphere which cools by thermal radiation. Results are presented in terms of dimensionless parameters. The Fortran computer program used to produce these results is also presented. (auth)

2086 (UCRL-50685) PHYSIOLOGY OF THE PUBLISHER PROGRAM. Lawrence, J. Dennis (California Univ., Livermore. Lawrence Radiation Lab.). June 16, 1969. 301p. Dep. CFSTI.

Publisher is a computer program used to write notes and reports, to update them, and to obtain multiple copies for rapid distribution. This report describes, for the programmer, the implementation of Publisher on the Control Data Corporation 3600 and 6600 computers. It includes a complete description of the program structure and the variables that are used, plus an analysis of the coding. This analysis includes flowcharts and descriptive narrative of the detailed source program listing. An illustrative appendix occurs at the end of the report. (auth)

2087 (Y-1693) AUTOMATED ULTRASONIC NONDESTRUCTIVE TESTING SYSTEM. Maxson, R. C. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Nov. 5, 1969. Contract W-7405-eng-26. 50p. Dep. CFSTI.

A small, general-purpose computer was used to automate an ultrasonic inspection machine designed to evaluate the internal integrity of flat plates and right circular cylinders. Application of the computer extended the capabilities of the basic system to include inspection of free-form surfaces of revolution. The automated system controls the positioning of the ultrasonic probe to maintain the probe perpendicular to and at a constant distance from the part surface. Using the front surface echo as the feedback control parameter, the desired tracking was achieved. Development of the automatic control system has greatly increased the versatility of the inspection device. (auth)

2088 (Y-1702) PUNCHED-TAPE CODE AND FORMAT FOR NUMERICALLY CONTROLLED MACHINES. Miskell, R. V. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Nov. 5, 1969. Contract W-7405-eng-26. 15p. Dep. CFSTI.

A description of the newer punched-tape codes and formats for numerically controlled machines is presented. The description of the systems will assist personnel who are responsible for the procurement and operation of numerically controlled machines. (auth)

2089 AEC AUTHORIZING LEGISLATION, FISCAL YEAR 1970. PART 1. HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATE, NINETY-FIRST CONGRESS, FIRST SESSION ON GENERAL,

PHYSICAL RESEARCH PROGRAM, SPACE NUCLEAR PROGRAM, AND PLOWSHARE, APRIL 17 AND 18, 1969. Washington, D. C., Joint Committee on Atomic Energy, 1969. 855p. GPO $3.50.

The Commissions operating funds and its requests for funds for plant and capital equipment obligations for the physical research program, space nuclear program, and Plowshare are reviewed. In addition to the hearings, supporting documentation is also included. (C.E.S.)

2090 LIFE SCIENCES AND SPACE RESEARCH VII. Proceedings of the Open Meeting of Working Group V at the Eleventh Plenary Meeting of COSPAR, Tokyo, 14–16 May 1968 and The Symposium on Biological Effects of Radiation in Space, Tokyo, 10 May 1968. Vishniac, W.; Favorite, F. G. (eds.). Amsterdam, North-Holland Publishing Company, 1969. 219p. $14.00. (CONF-680530-(Vol.7); CONF-680555).

Ten separate abstracts were prepared for inclusion in NSA. Other papers from the conference presented are in the following topical sections: comparative methodology for study of nonterrestrial life; contamination and sterilization; meteorites; results of recent biological experiments in space flight; physiological adaptive mechanisms of man (and animals) to space flight conditions; regeneration life support system; exobiology; and a symposium on biological effects of radiations in space. (C.O.)

For abstracts of individual papers see: 593, 661, 829, 830, 846–849, 912, and 925.

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